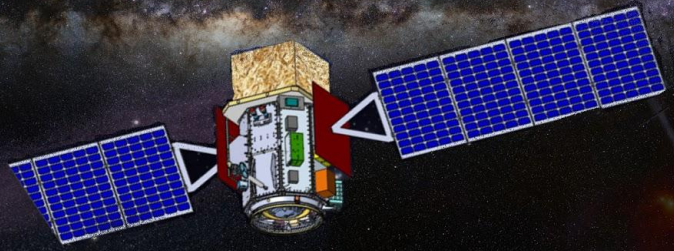
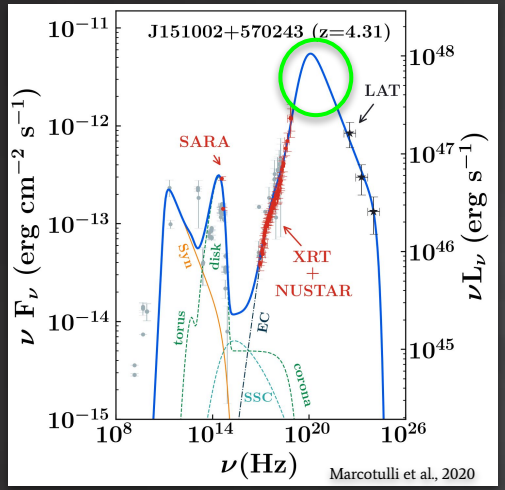
AGNs and their jets through a sensitive MeV eye



Presented by: Lea Marcotulli
On behalf of the AMEGO team

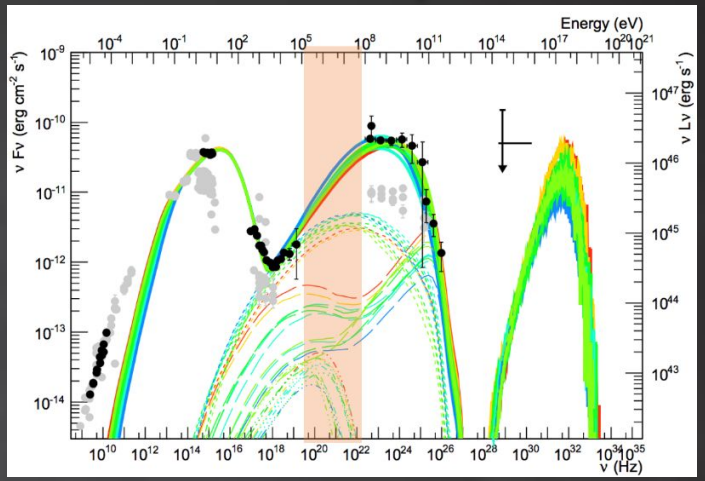
MeV Splinter Session
AAS 237, 11 Jan 2021

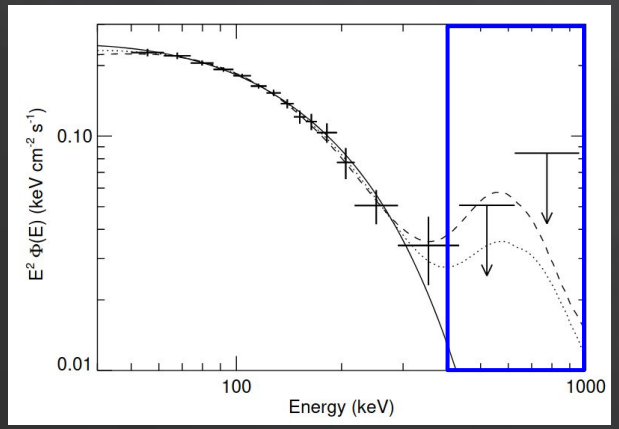
MeV blazars



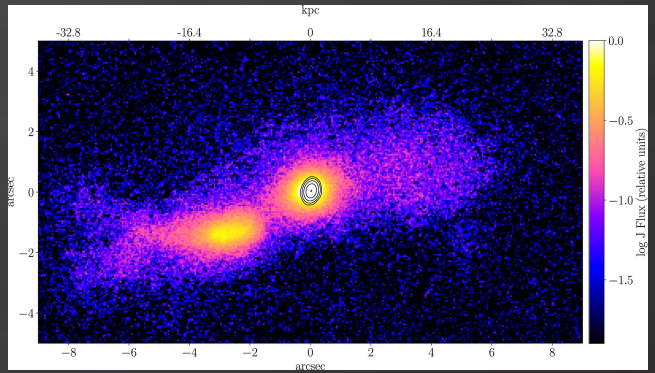
AGNs in the MeV

Hadronic vs. Leptonic emission





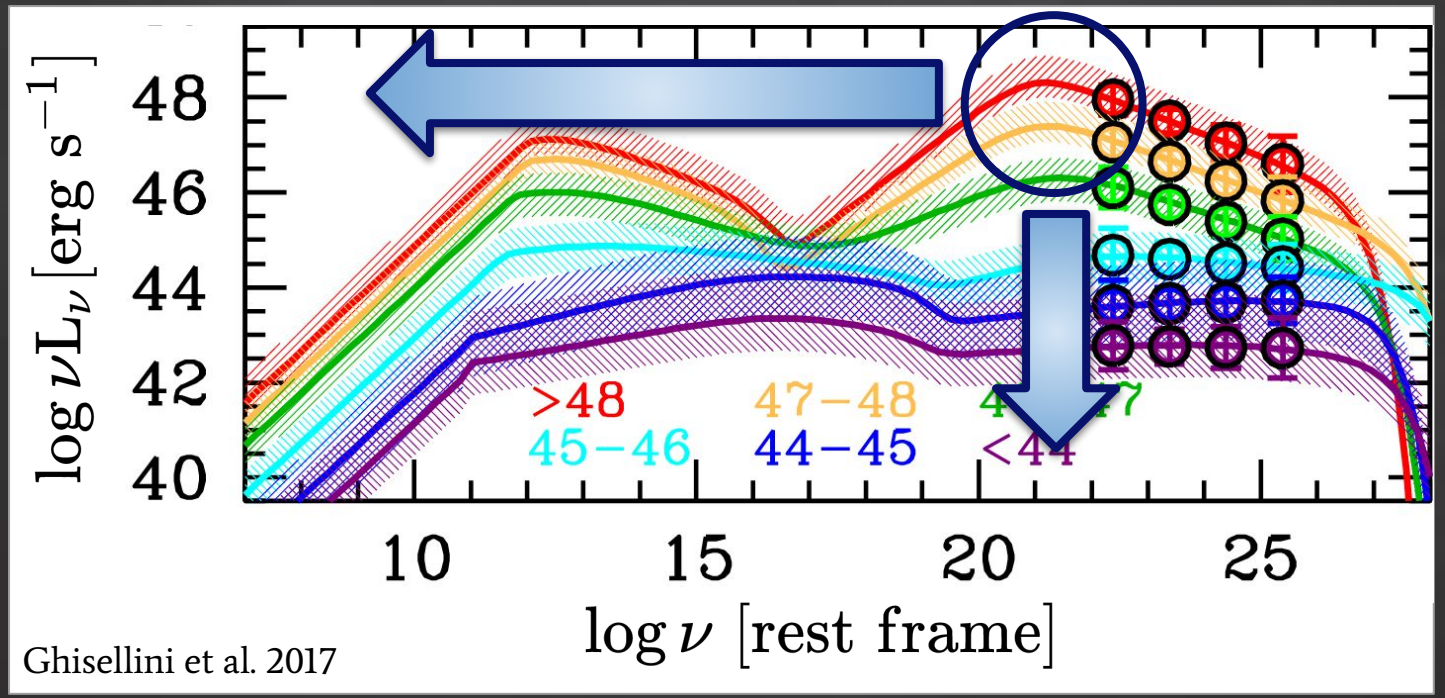
AGN corona



AGNs to be detected

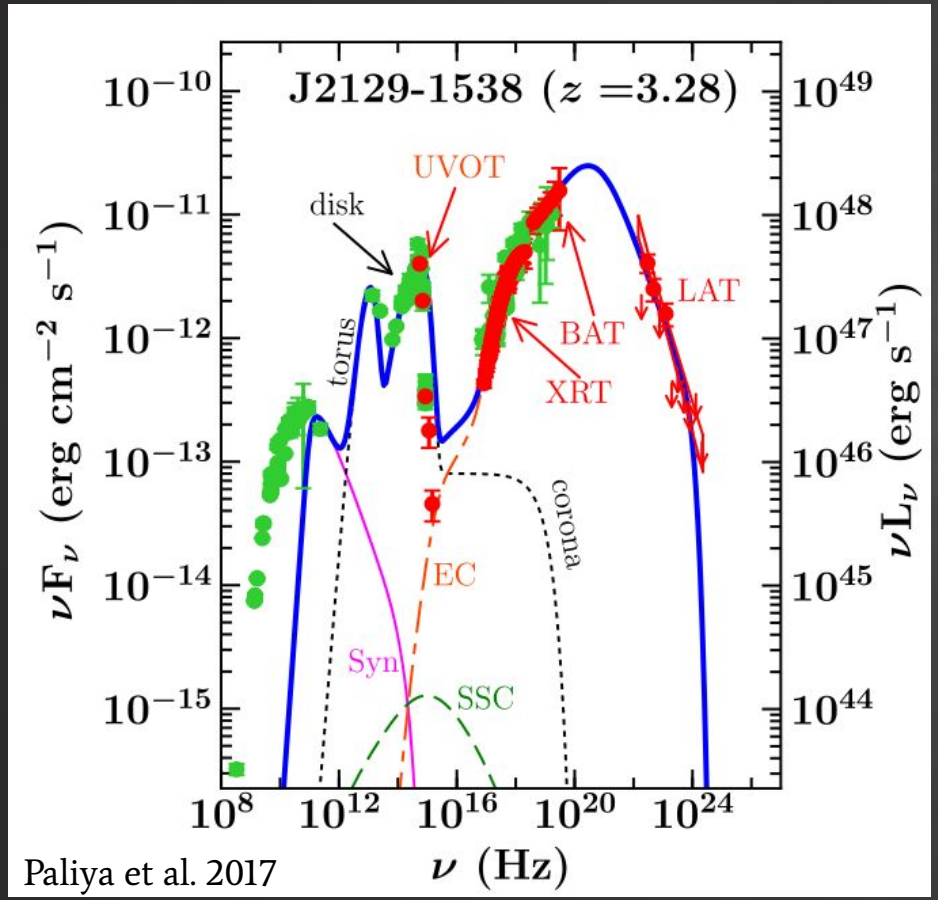
Blazar population

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



Ghisellini et al. 2017

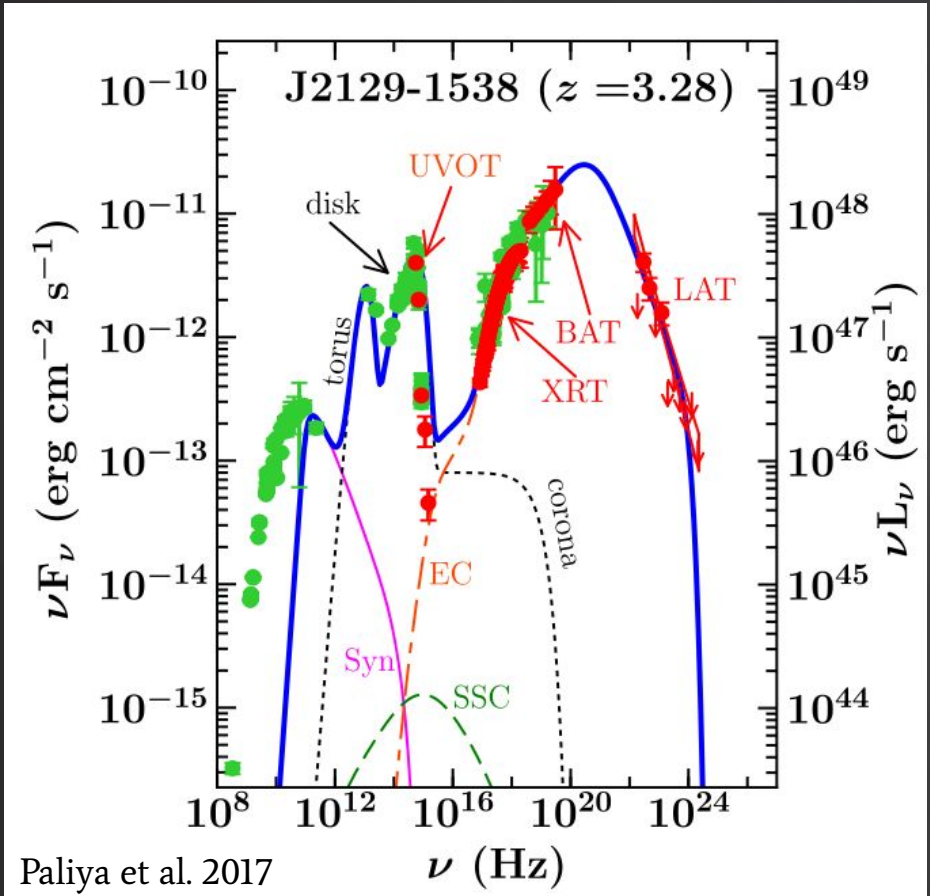
MeV blazars



Paliya et al. 2017

- They are among most powerful persistent objects in the Universe

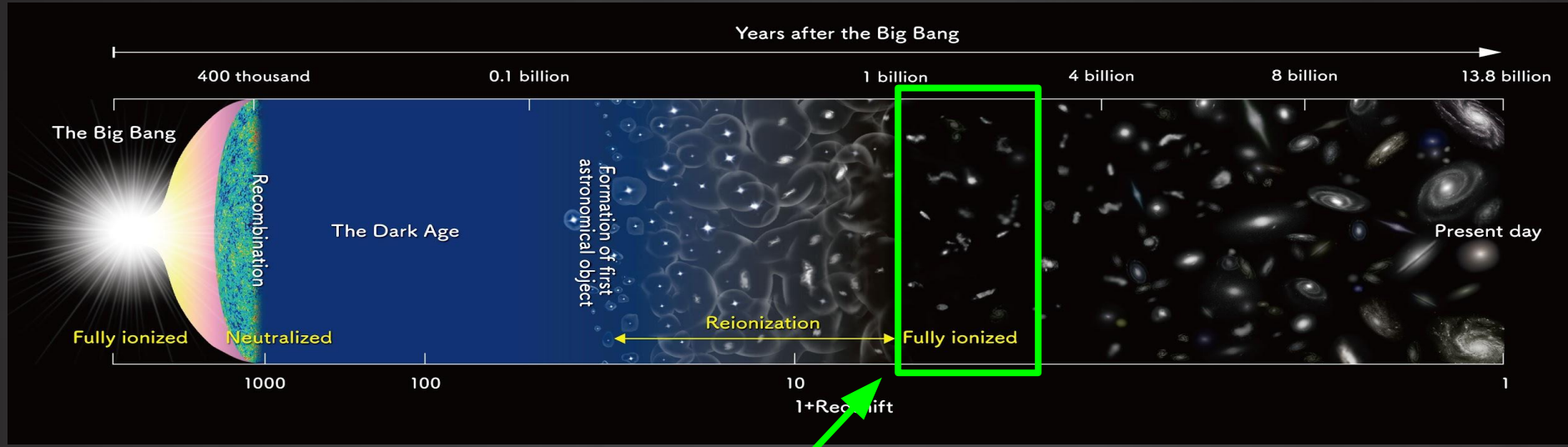
MeV blazars



Paliya et al. 2017

- They are among most powerful persistent objects in the Universe
- With large jet power that easily exceeds the accretion disk luminosity → Black hole spin may be important

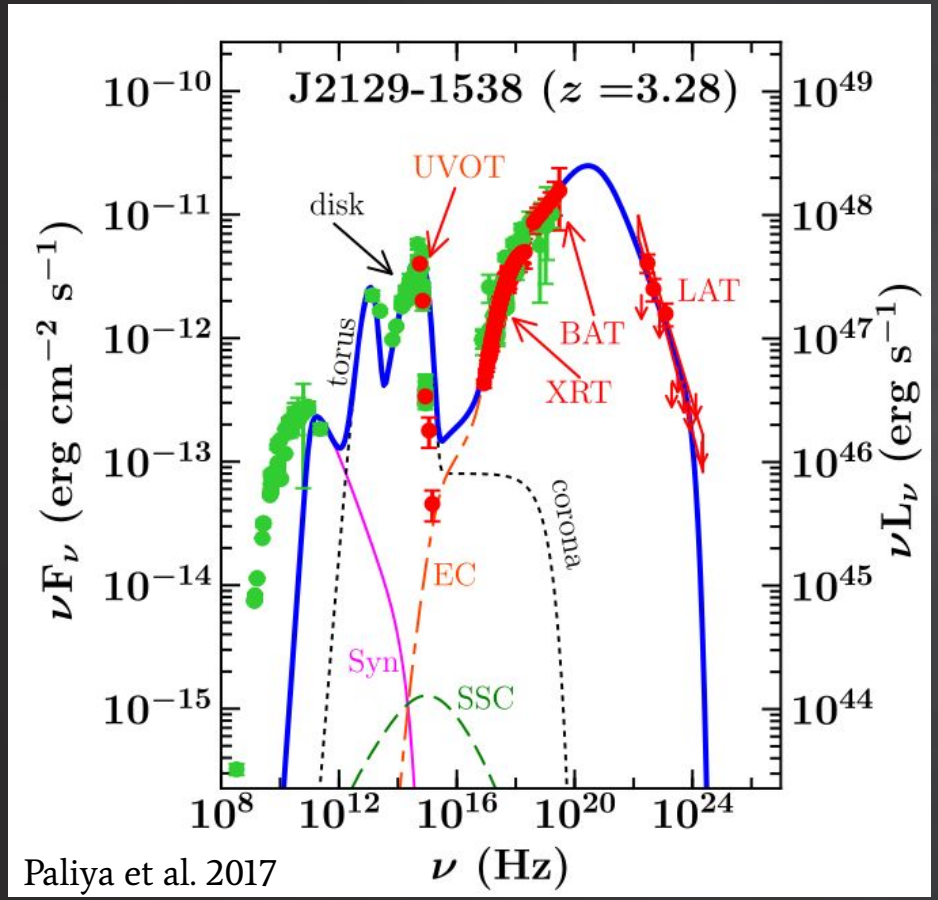
MeV blazars



- Detected up to very high redshifts (z>2, up to z~4,5, Ajello et al. 2009)

MeV BLAZARS

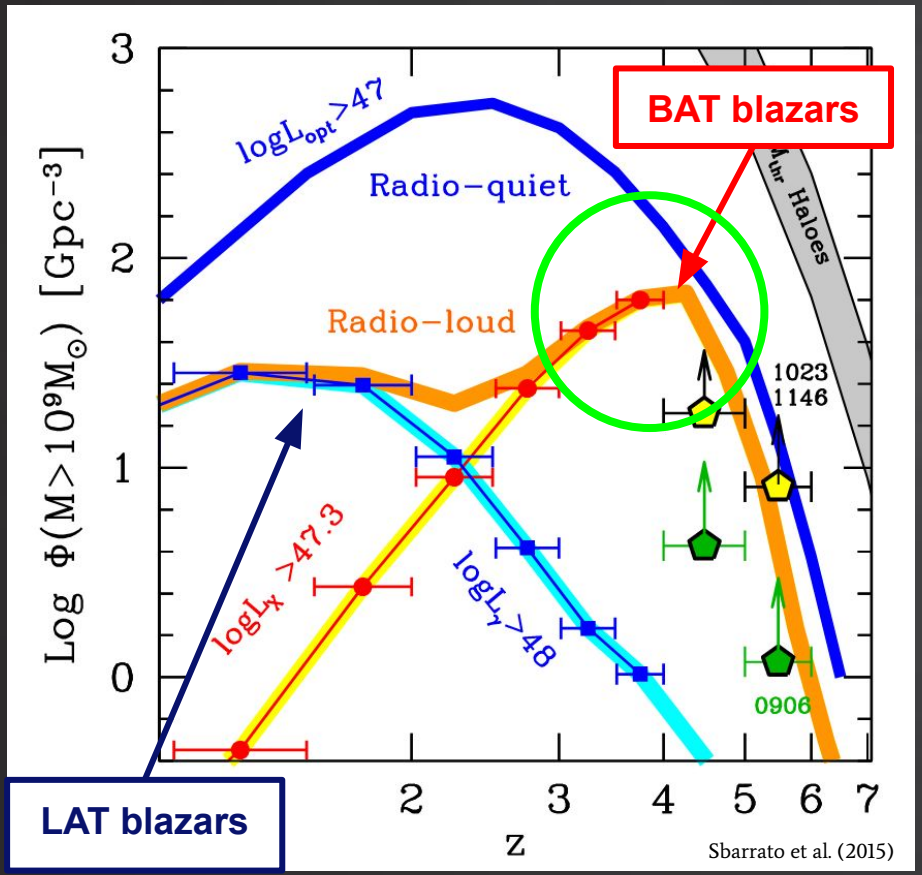
MeV blazars



Paliya et al. 2017

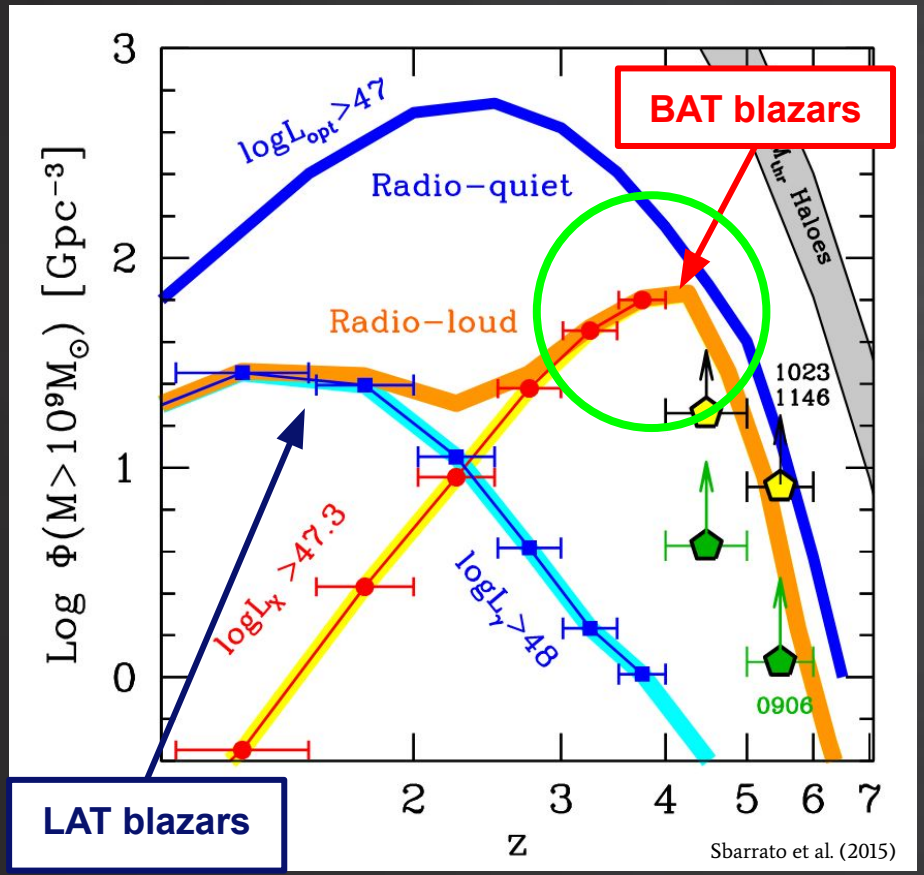
- They are among most powerful persistent objects in the Universe
- With large jet power that easily exceeds the accretion disk luminosity → Black hole spin may be important
- Detected up to very high redshifts (z>2, up to z~4,5, Ajello et al. 2009)
- They host extremely massive black holes ($M_{BH} \geqslant 10^9 M_\odot$)

Evolution of MeV Blazars



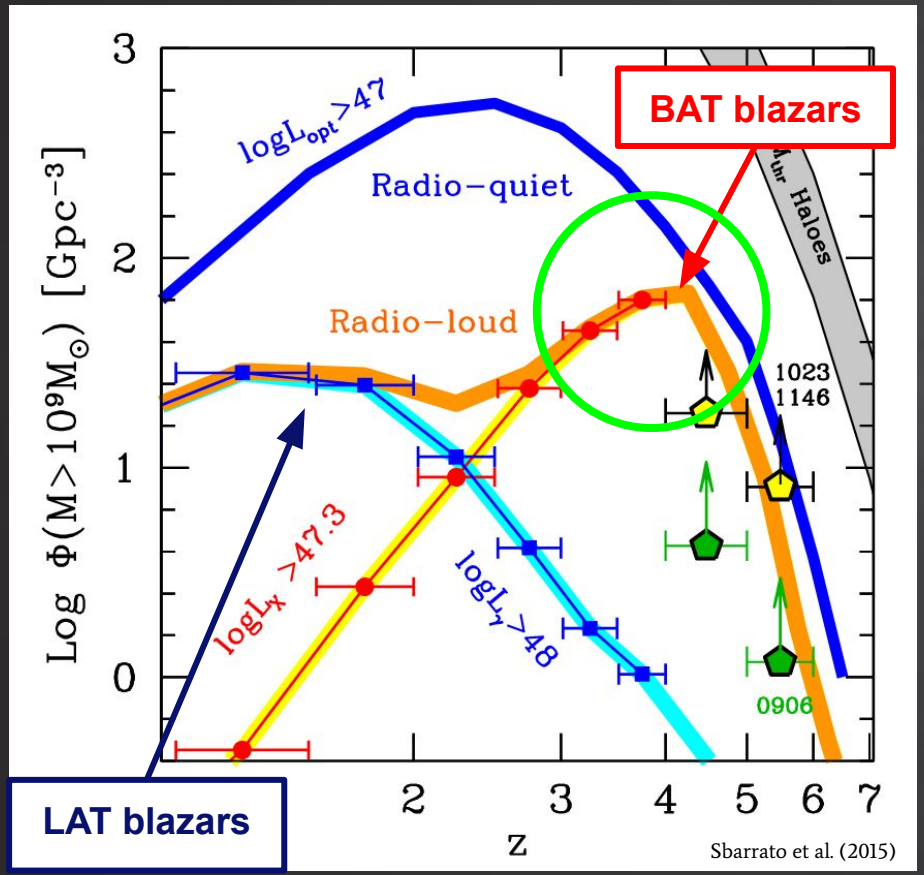
- Evolution of MeV blazars is stronger than any other source class: i.e. their maximum density may be very early on

Evolution of MeV Blazars



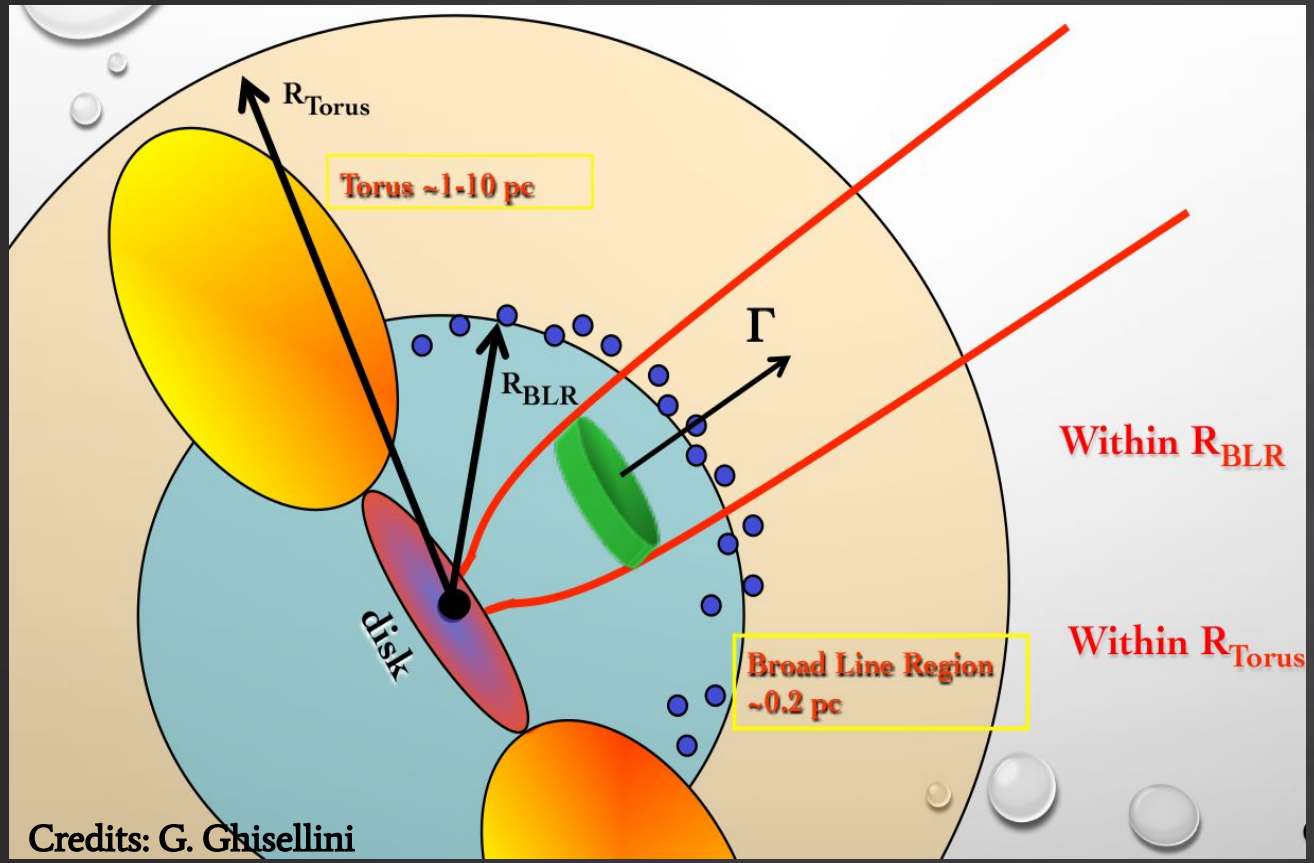
- Evolution of MeV blazars is stronger than any other source class: i.e. their maximum density may be very early on
- Clear that the radio-loud phase may play a very important role in the growing of massive black holes

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
- Constraining the number density of extremely massive black holes in radio-loud systems is the easiest with blazars (via $2\Gamma^2$ correction)

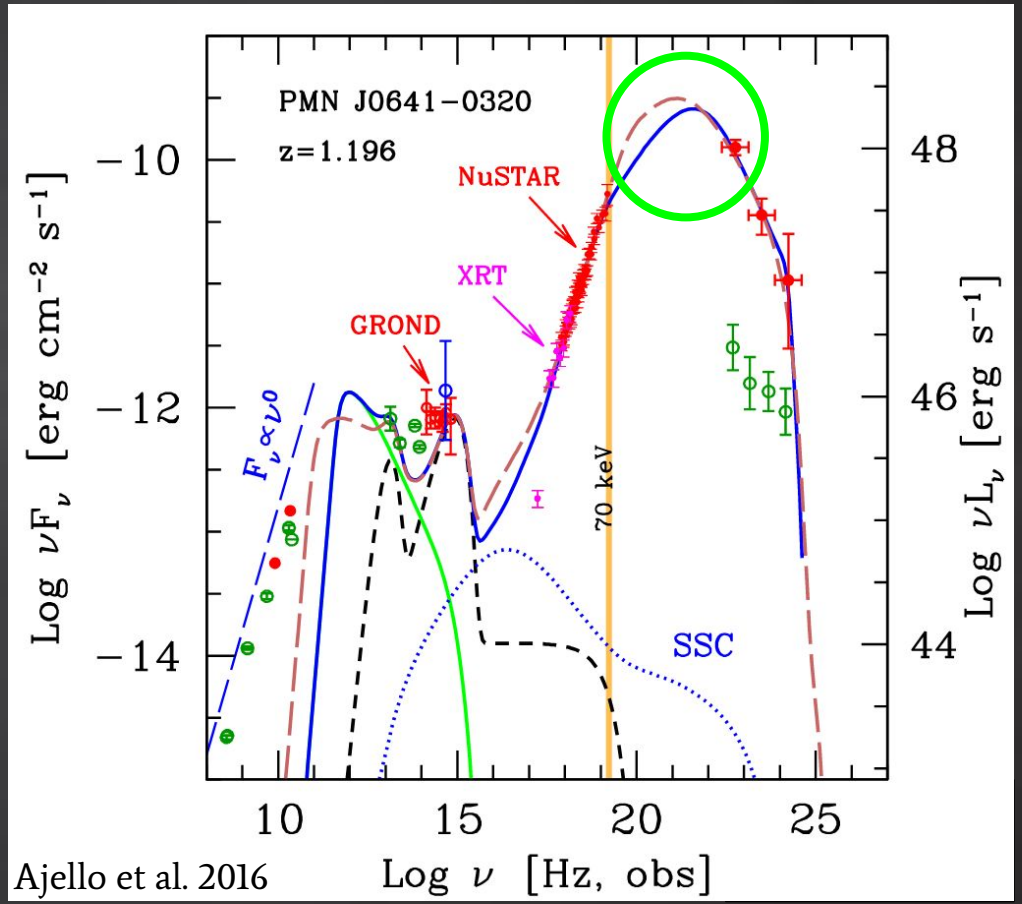
Where is the blazar zone?



Lack of strong absorption in the LAT energy range due to UV BLR photons places the emission region beyond the BLR (Costamante et al. 2018)

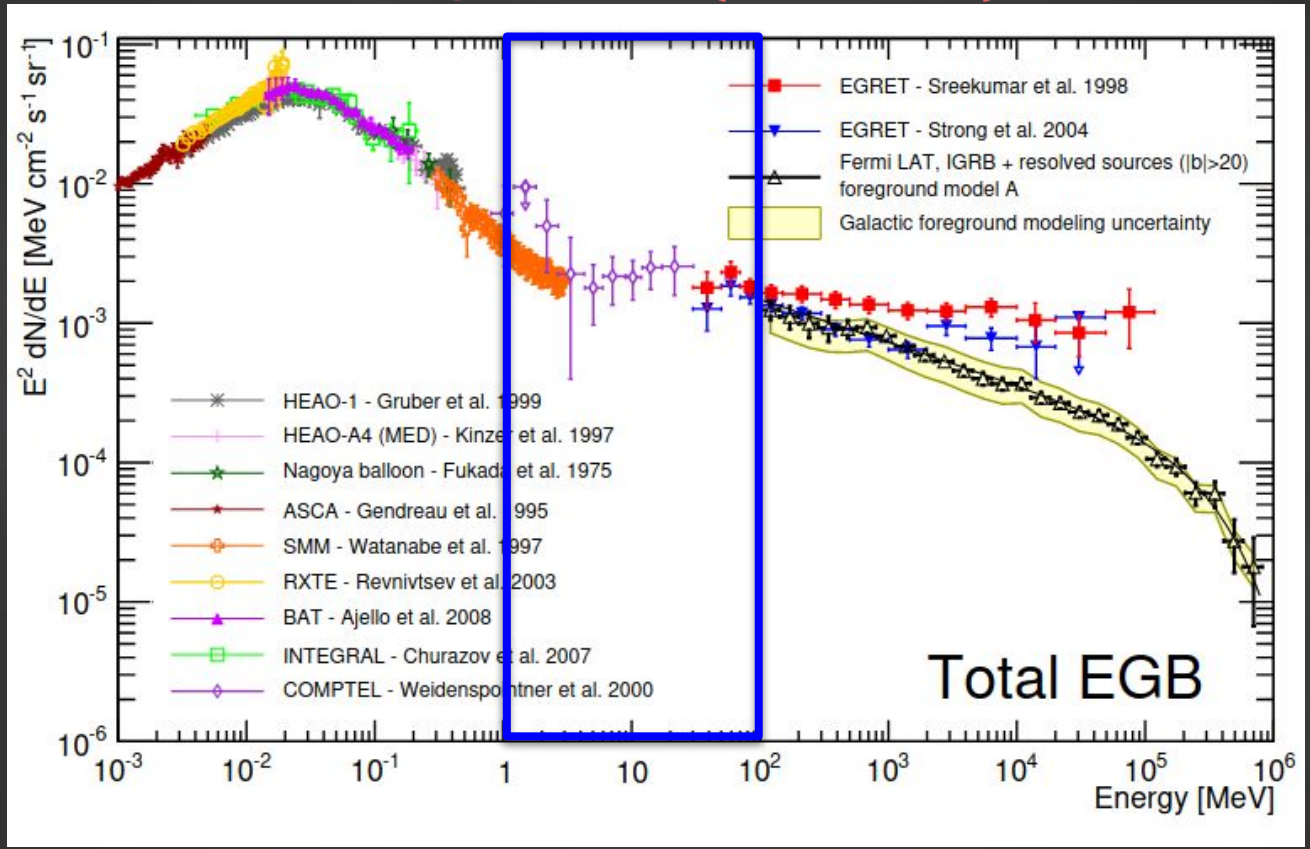
Where is the blazar zone?

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



Ajello et al. 2016

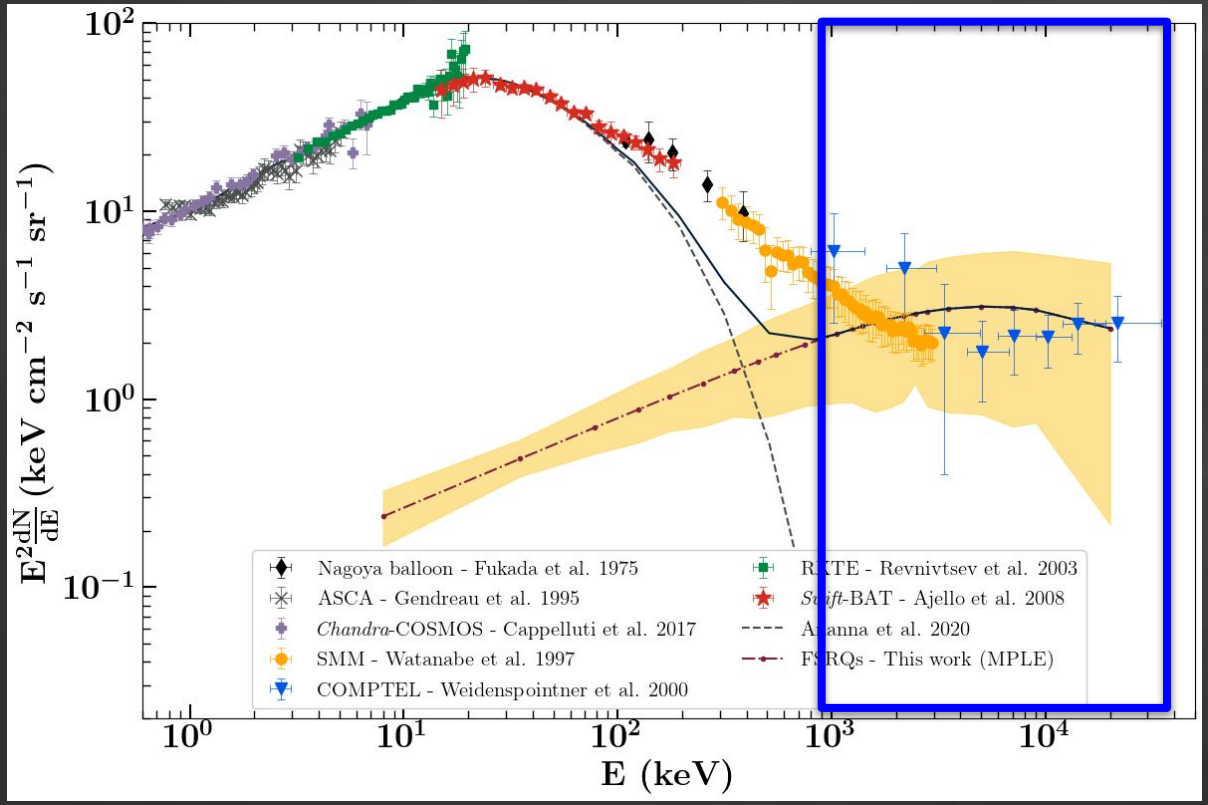
The Cosmic MeV Background (CMeVB)



Ackermann et al. 2015

MeV blazars for the CMeVB

MeV blazars can contribute up to 100%!



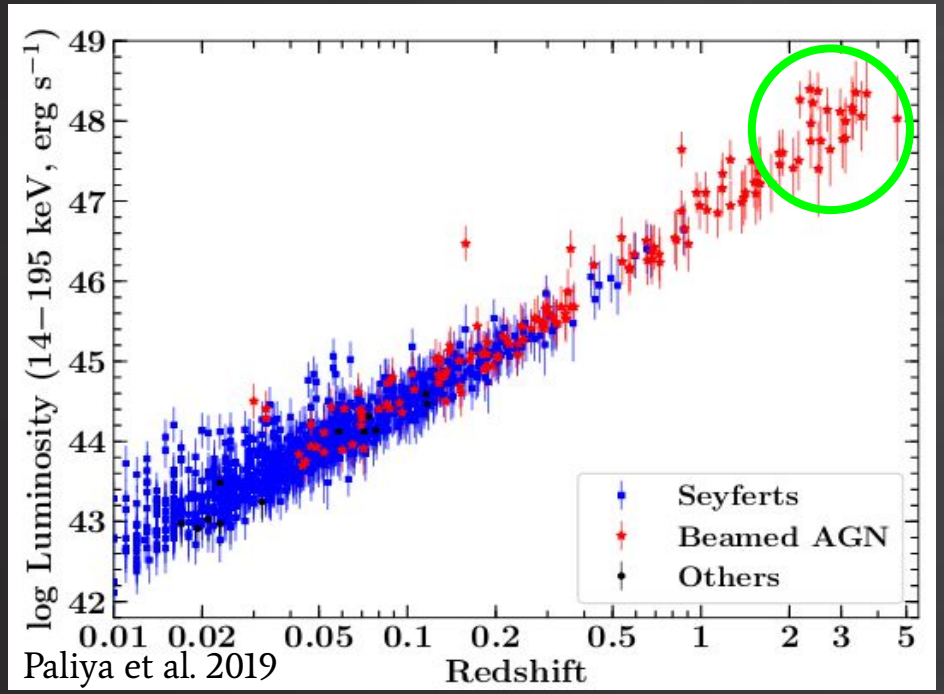
Marcotulli et al. in prep

Current status

MeV blazars are hard to detect despite being bright!

Current status

MeV blazars are hard to detect despite being bright!



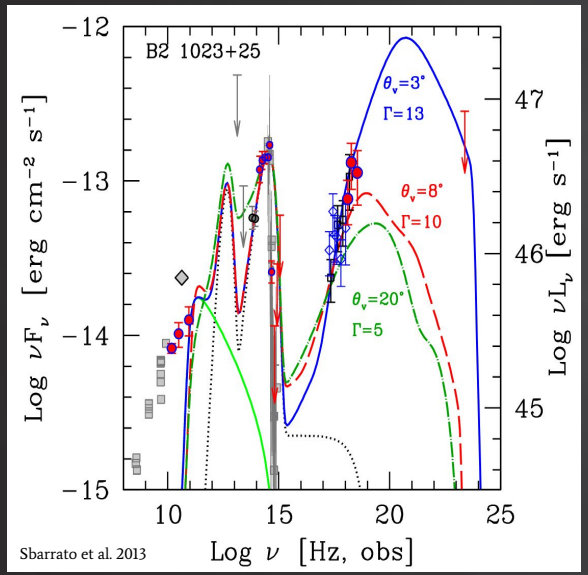
Paliya et al. 2019

Bright in X-rays ($L_X > 10^{46}$ er s^{-1})

a. Tens detected by Swift/BAT (Ajello et al, 2009, Paliya et al. 2019)

Current status

MeV blazars are hard to detect despite being bright!

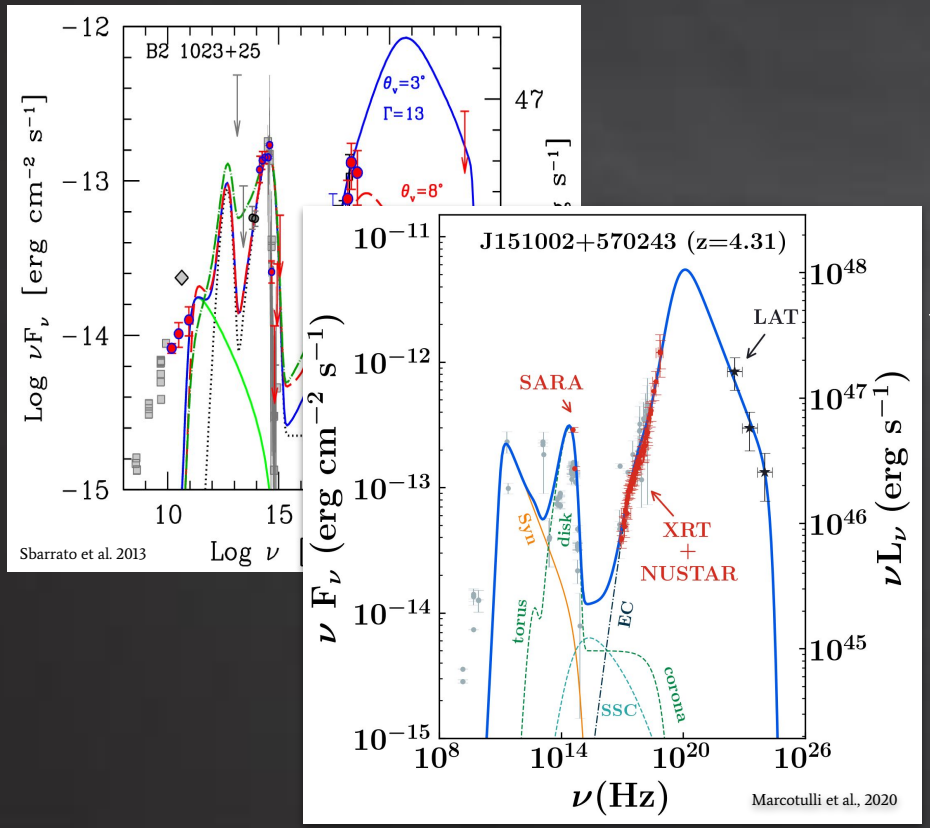


Bright in X-rays ($L_X > 10^{46}$ er s^{-1})

a. Tens detected by Swift/BAT (Ajello et al, 2009, Paliya et al. 2019)
b. Few discovered (via follow up) with NuSTAR (Ghisellini, Sbarrato etc)

Current status

MeV blazars are hard to detect despite being bright!

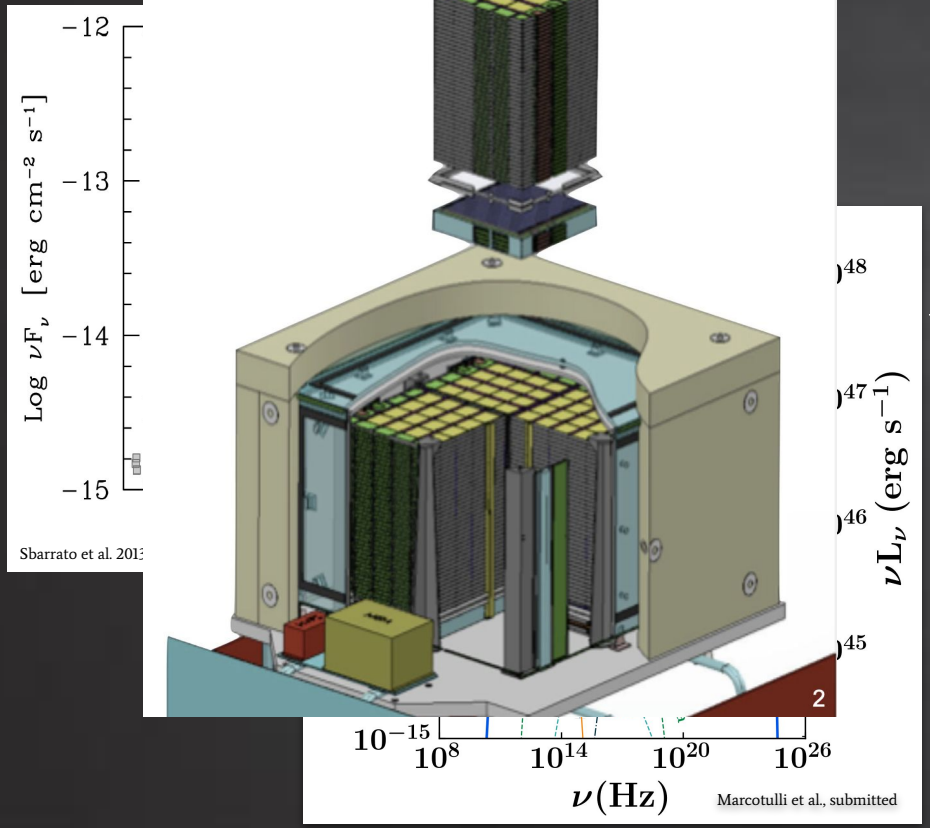


Bright in X-rays ($L_X > 10^{46}$ er s^{-1})

a. Tens detected by Swift/BAT (Ajello et al, 2009, Paliya et al. 2019)
b. Few discovered (via follow up) with NuSTAR (Ghisellini, Sbarrato etc) and Fermi-LAT (Ajello, Paliya, Marcotulli etc.)

Current status

MeV t despite being bright!



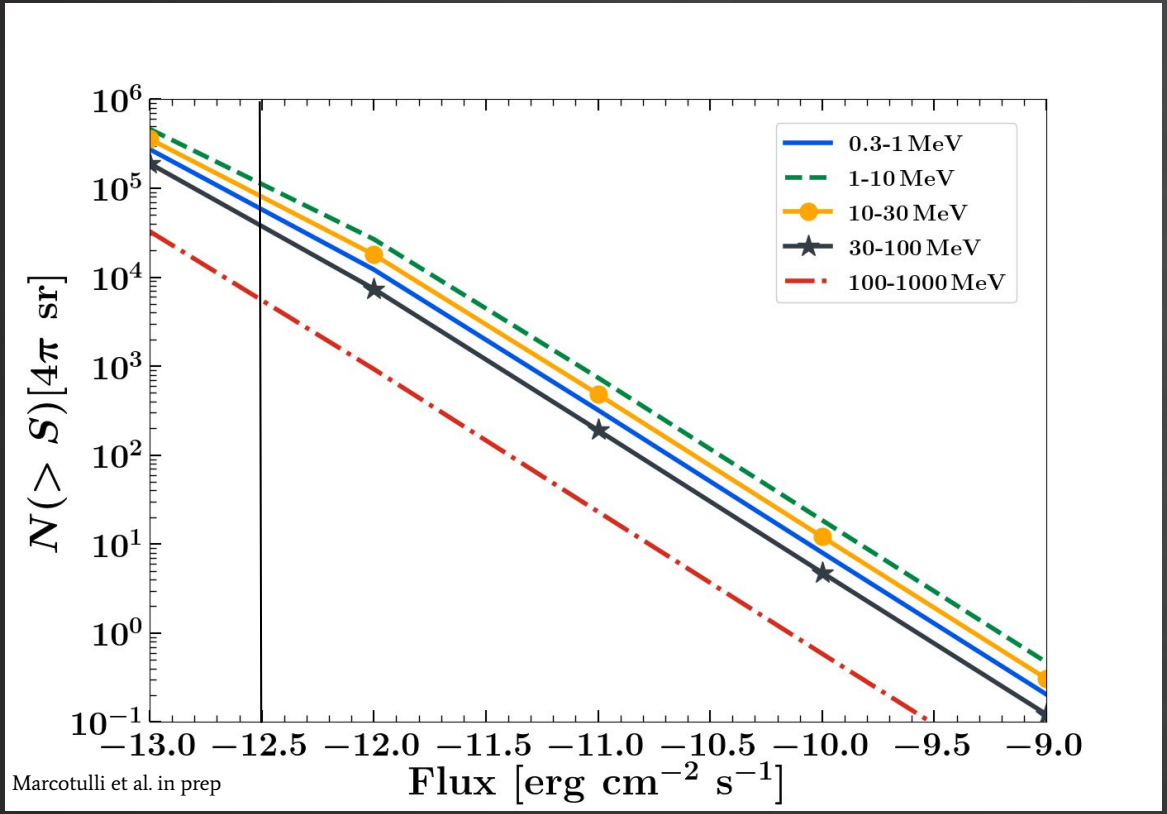
Bright in X-rays (L_X>10^{46} er s^{-1})

a. Tens detected by Swift/BAT (Ajello et al, 2009, Paliya et al. 2019)
b. Few discovered (via follow up) with NuSTAR (Ghisellini, Sbarrato etc) and Fermi-LAT (Ajello, Paliya, Marcotulli etc.)

Need an all-sky MeV mission!!!

How many blazars can be detected?

More than 100 blazars at z>3!!!



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

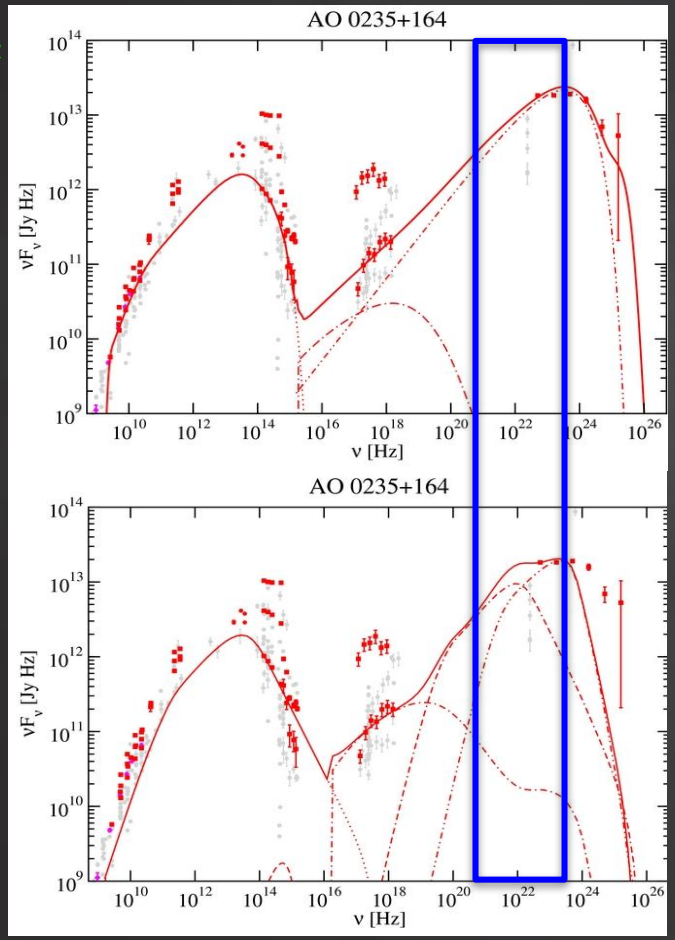
PLE Evolution (A09) up to high *z*.

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

HADRONIC vs. LEPTONIC MODELs

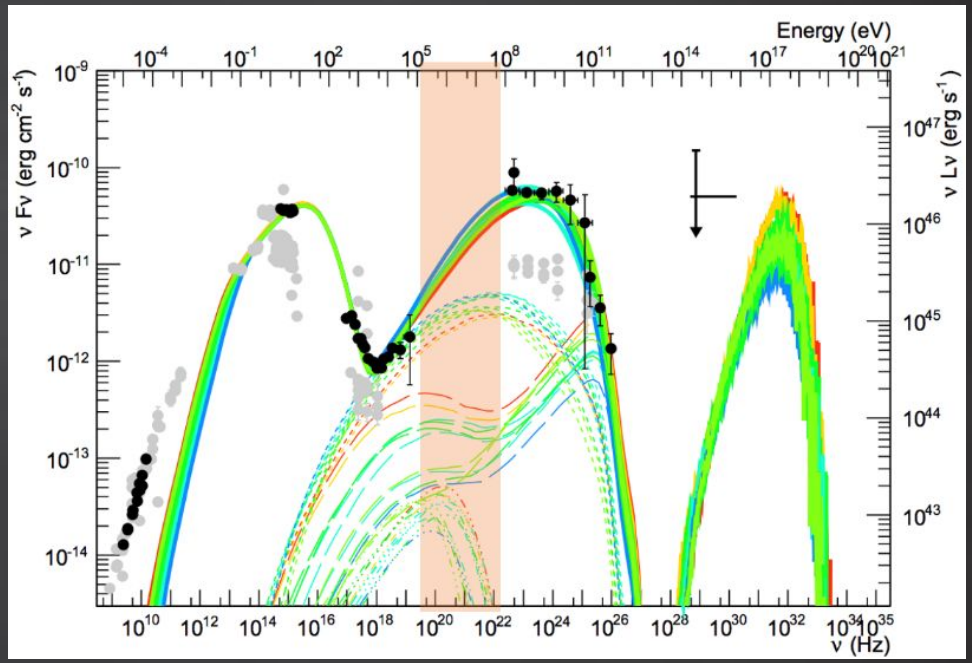
Leptonic

Hadronic



Böttcher et al. 2013

TXS 0506+056 (lepto-hadronic model)

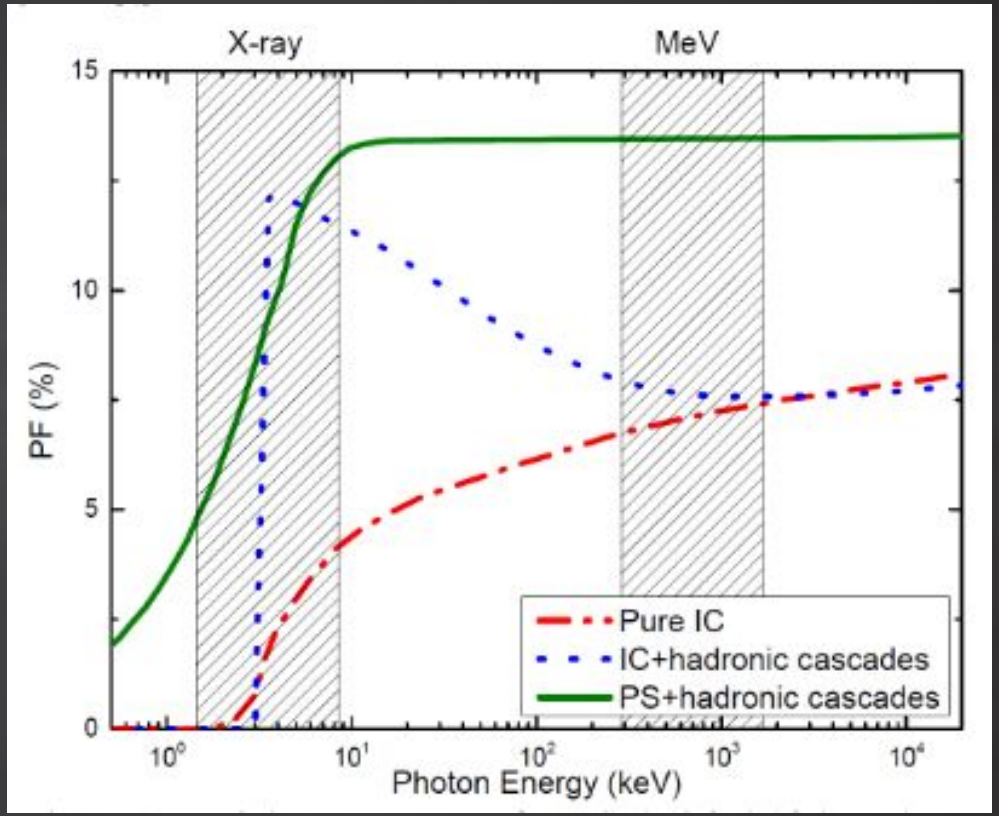


Ojha et al. Astro 2020, adapted from Cerruti et al. 2018

HADRONIC vs. LEPTONIC MODELs

Leptonic → pure IC

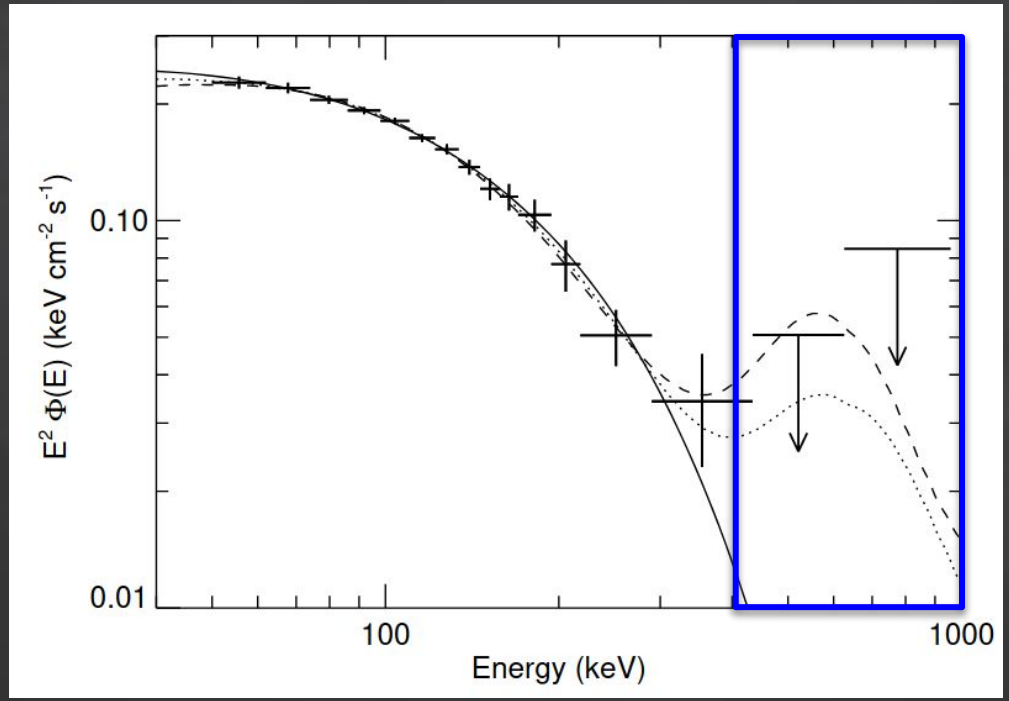
Hadronic → proton synchrotron + hadronic cascades



Rani B. et al. Astro 2020, adapted from Zhang et al. 2019

AGN CORONA

Possible peak in MeV band from IC of pairs with accretion disk photons

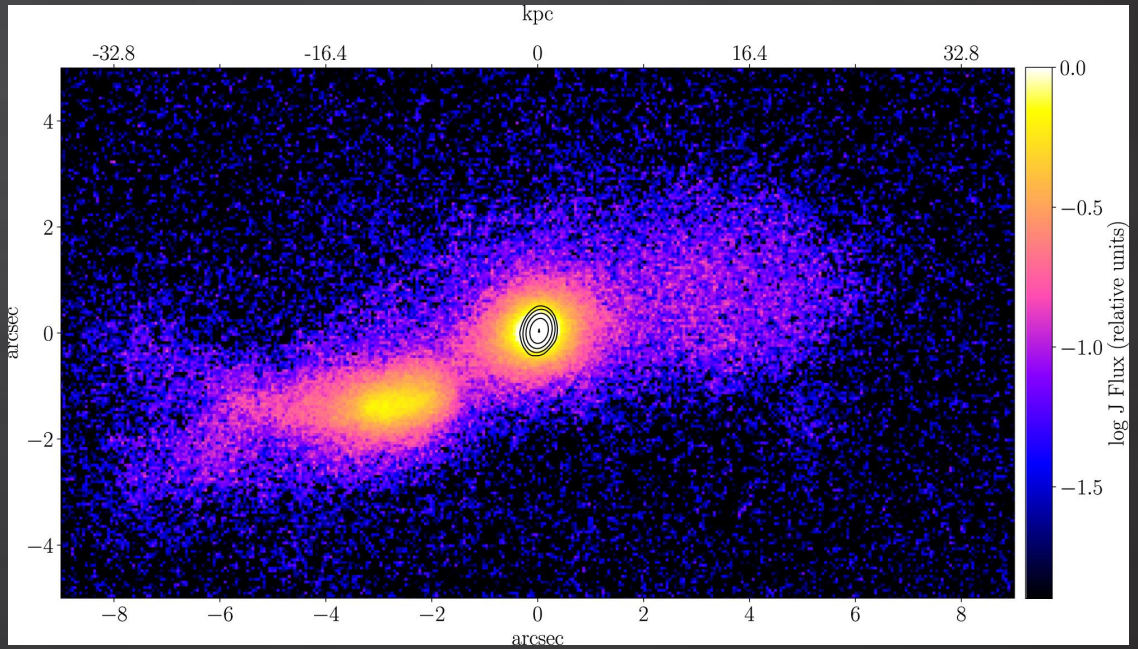


Johnson et al. 1997

OTHER AGNs to be detected

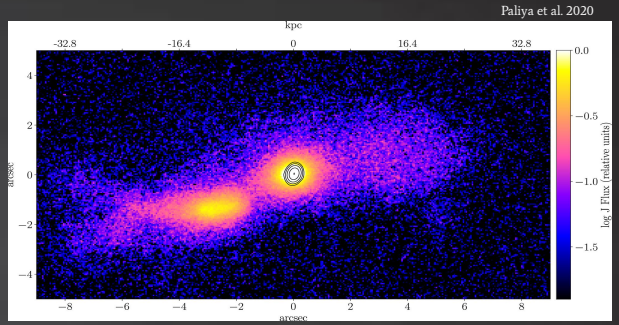
- γ-NLSys

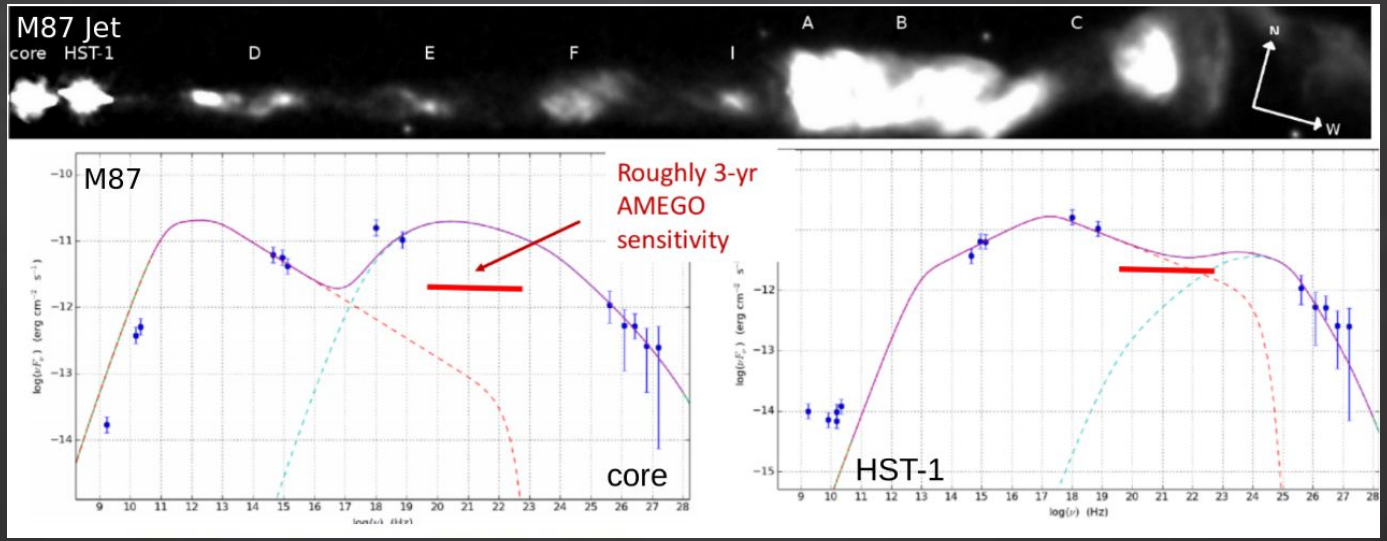
Paliya et al. 2020



OTHER AGNs to be detected

- γ-NLSys
- Radio Galaxies

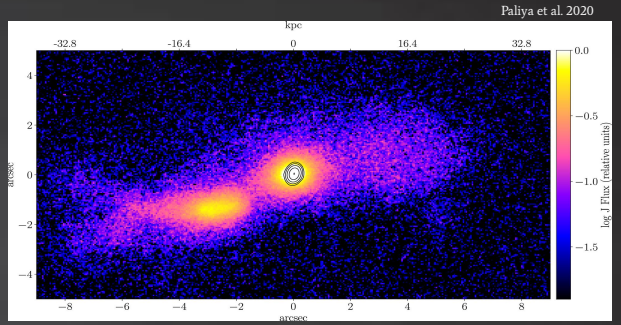


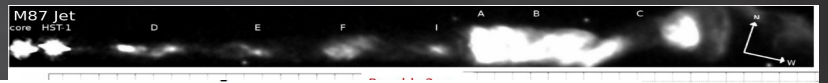


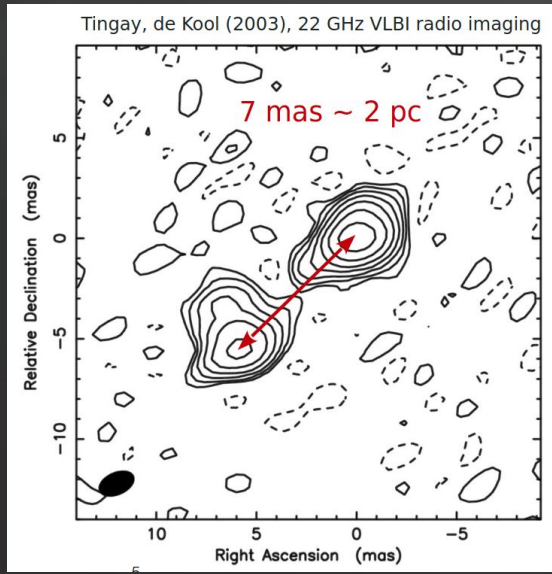
Meyer et al. Astro 2020, adapted from Meyer et al. 2013 and de Jong et al. 2015

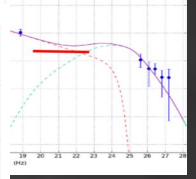
OTHER AGNs to be detected

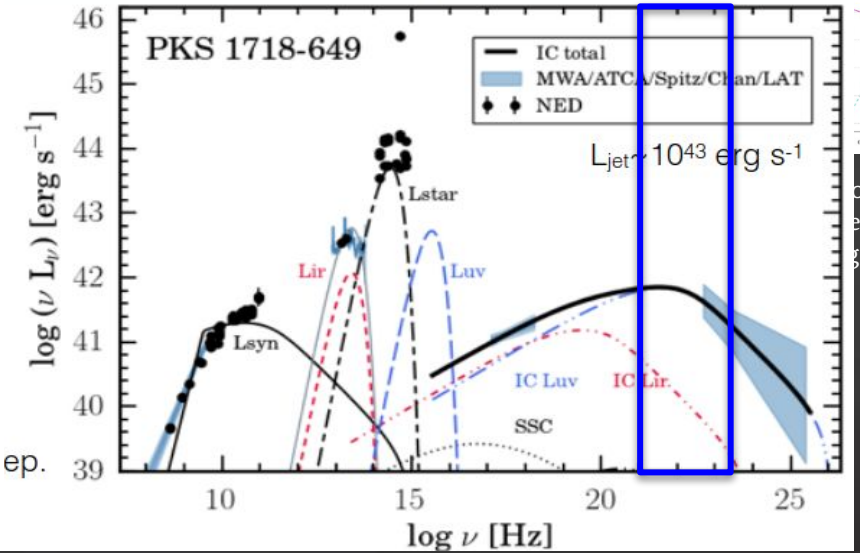
- γ-NLSys
- Radio Galaxies
- Compact Steep Spectrum Objects







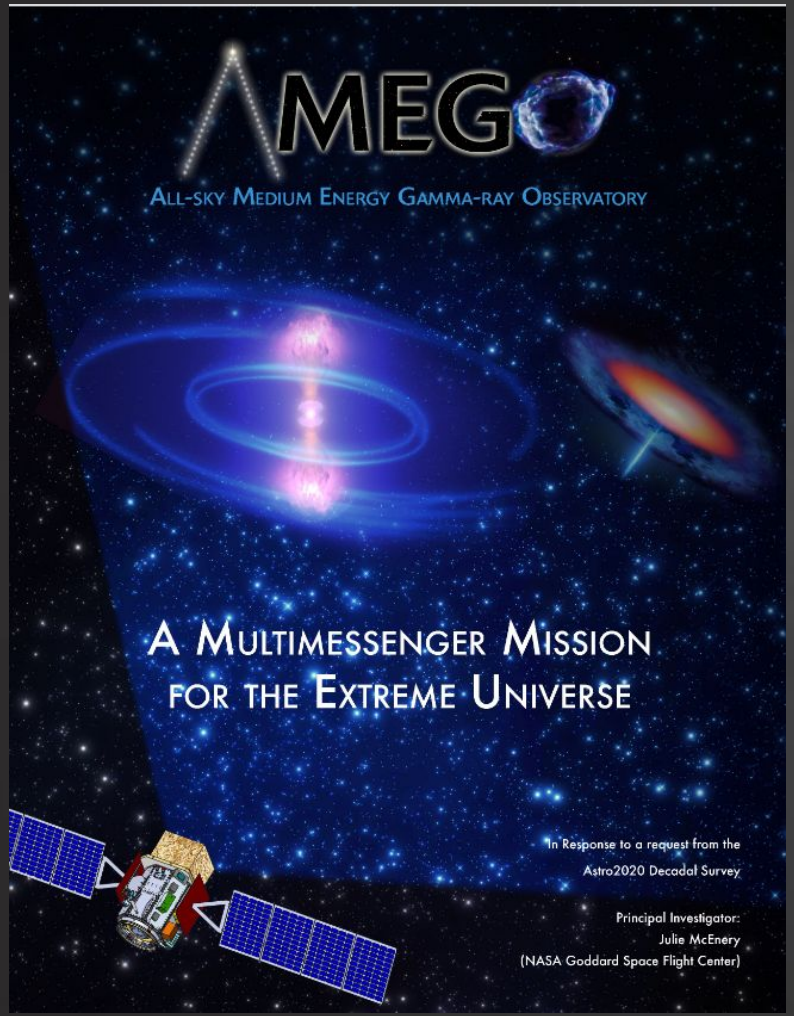




ep.

o 2020,
eyer et al.
g et al. 2015

Migliori et al. 2016



Summary

An MeV mission (like AMEGO) will:

1. Detect hundreds of MeV blazars up to z~5 and maybe beyond
2. Help us constrain supermassive black hole growth theories
3. Explore the disk-jet connection beyond z=3
4. Constrain the location of the blazar emission region (BLR vs. Torus)
5. Understand blazar contribution to the the MeV background
6. Discern hadronic vs. leptonic emission processes in blazars
7. Untangle physics of corona emission
8. Detect 10ths to 100ths of gamma undetected AGN sources that peak in MeV

AND MORE!!!