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
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 detected by LAT is at $z=3.1$
  - MeV blazars easily reach $z=5$

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Sambruna+06

Ghisellini+10
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

Sambruna+06

Ghisellini+10
• 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

**Swift/BAT FSRQs, Ajello+09**
• 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 $10^5 M_{\text{sun}}$ 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

Ojha @ 227th AAS meeting
Current Status

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

Sbarrato+15

\[ P_j \text{ [erg s}^{-1}] \]

\[ L_d \text{ [erg s}^{-1}] \]

Sbarrato+14

\[ \log \Phi(N>10^{9}M_\odot) \text{ [Gpc}^{-3}] \]

\[ z \]

Radio–quiet

Radio–loud

\[ \log L_{opt}>47 \]

\[ \log L_{X}>48 \]
The MeV Background

Ackermann+15
Many Hypotheses ... few answers

SN la, Watanabe+99

AGN Coronae, Inoue/Totani+

Hard FSRQs, Ajello+09

RGs (IC/CMB) Massaro&Ajello2011
Many Hypotheses … few answers

Ruiz-Lapuente 2016, but also Horiuchi & Beacon 2010

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Hard FSRQs, Ajello+09

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