2011 Fermi Symposium

"BLRGs" Observed w/ Fermi-LAT: Disentangling the Jet and the Disk Emission Spectra

ApJ submitted

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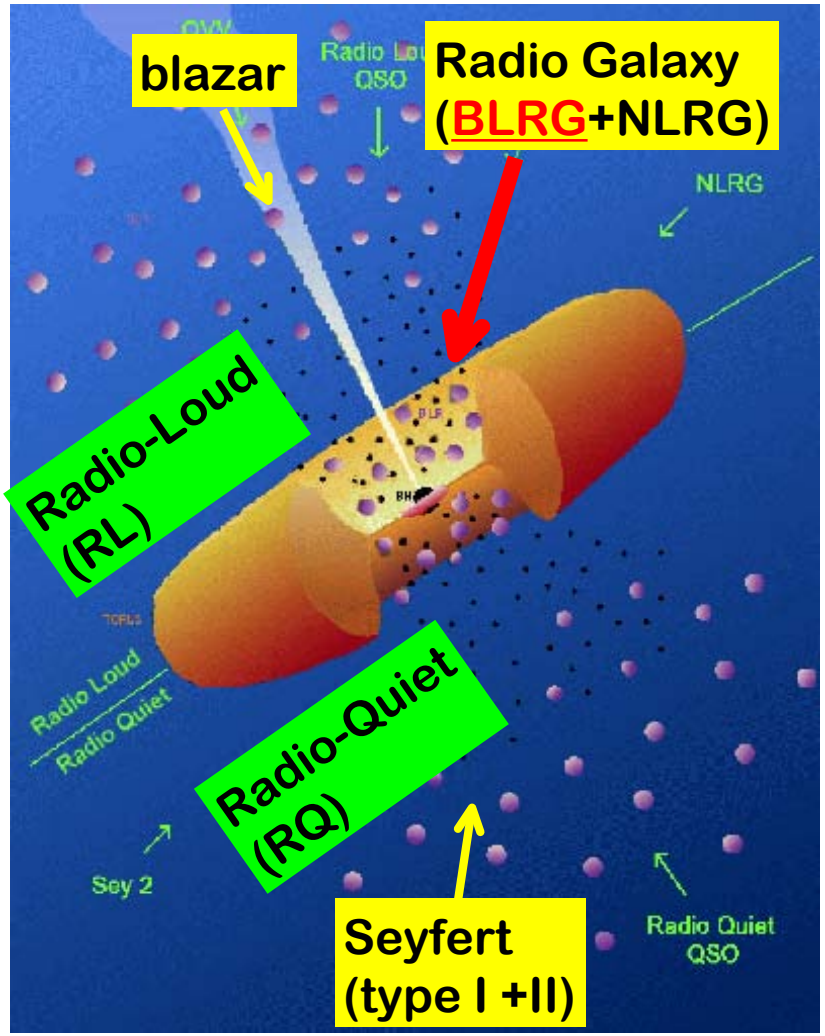
Toward AGN unification; BLRGs



Urry & Padovani 1995 for a review

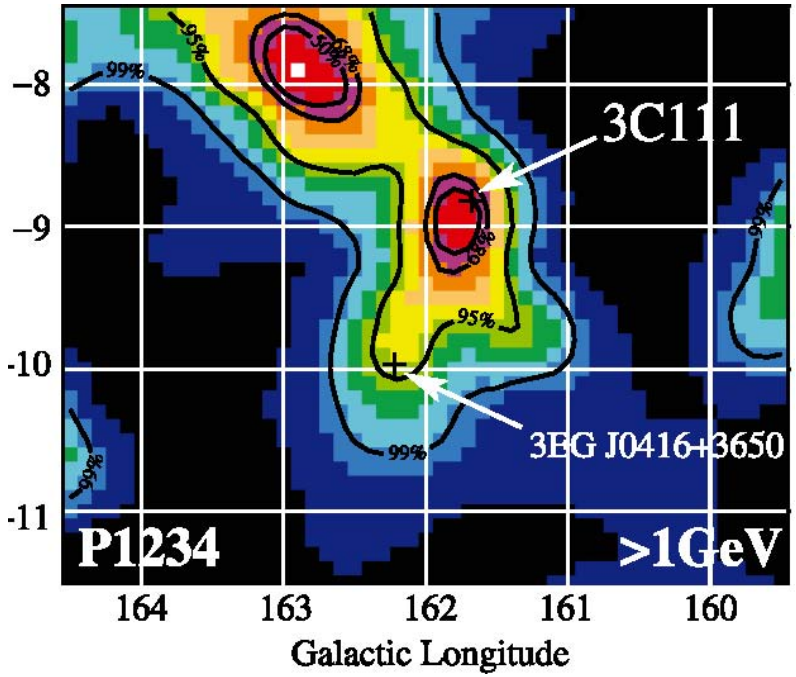
- A long debated problem in our understanding of SMBHs is the unifications of different types of AGNs.
- Broad line radio galaxies (BLRGs) are ideal targets, since they exhibit both the disk-related "Seyfert-like" and the jet-related "Blazar-like" radiative signature, without being obscured by large amounts of gas.

  (e.g., Wozniak+98, Grandi+02, Kataoka+07, Grandi & Palumbo 08, Sambruna+09 …)
- Our primary goals are to examine the γ-ray properties of BLRGs as potential "γ-loud" AGN, in a broad context of AGN unification scheme.

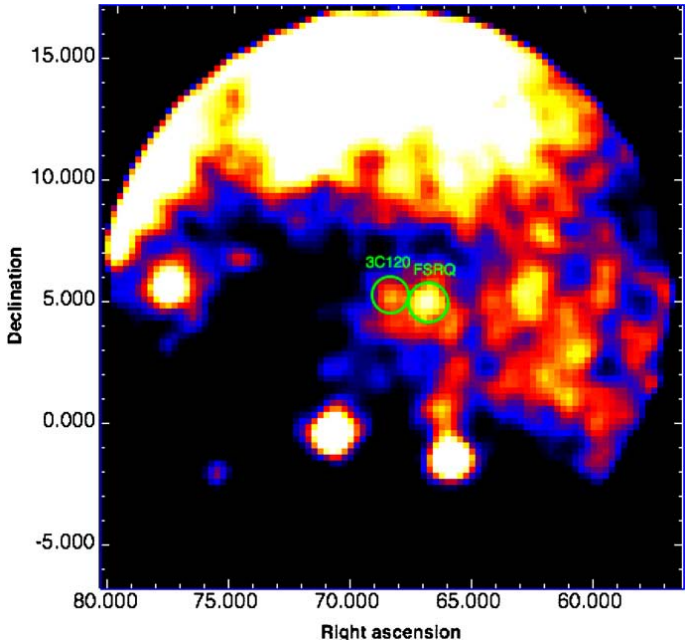
Fermi-LAT observations; samples

- All the BLRGs observed by modern X-ray astronomy satellites, for which data are available at energies above 2 keV.
- A representative sample of Sy-1 galaxies with known radio fluxes and BH mass. → 18 BLRGs + 9 Sy-1s of high-accretion-rate
- Already known γ-ray sources: 3C111, 3C120 … and more ???

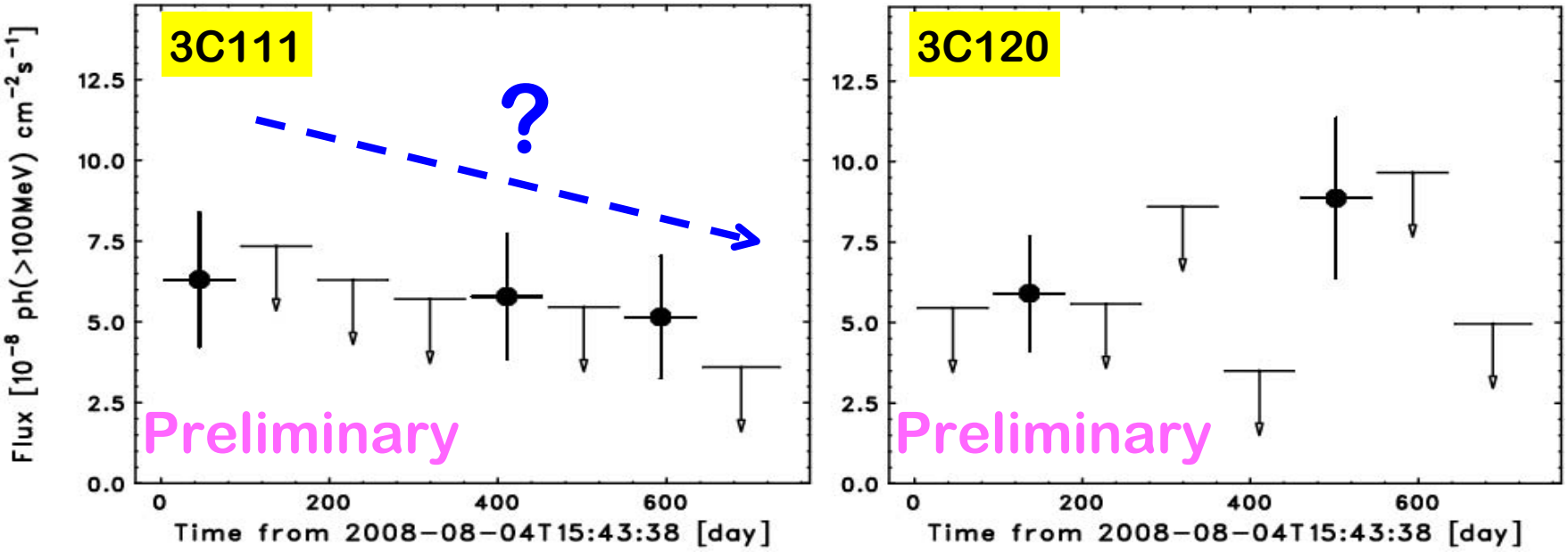
Hartman+ 2008 (EGRET), Abdo+ 2010

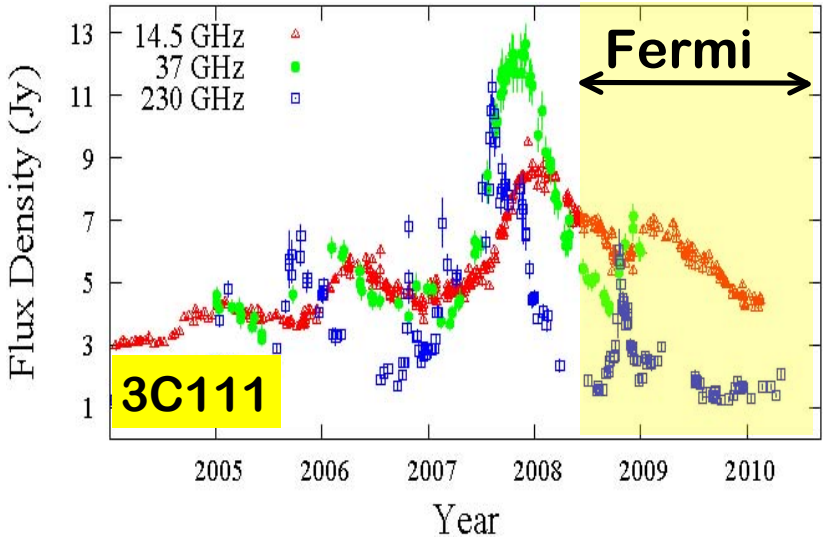


Abdo+ 2010 (Fermi-LAT)



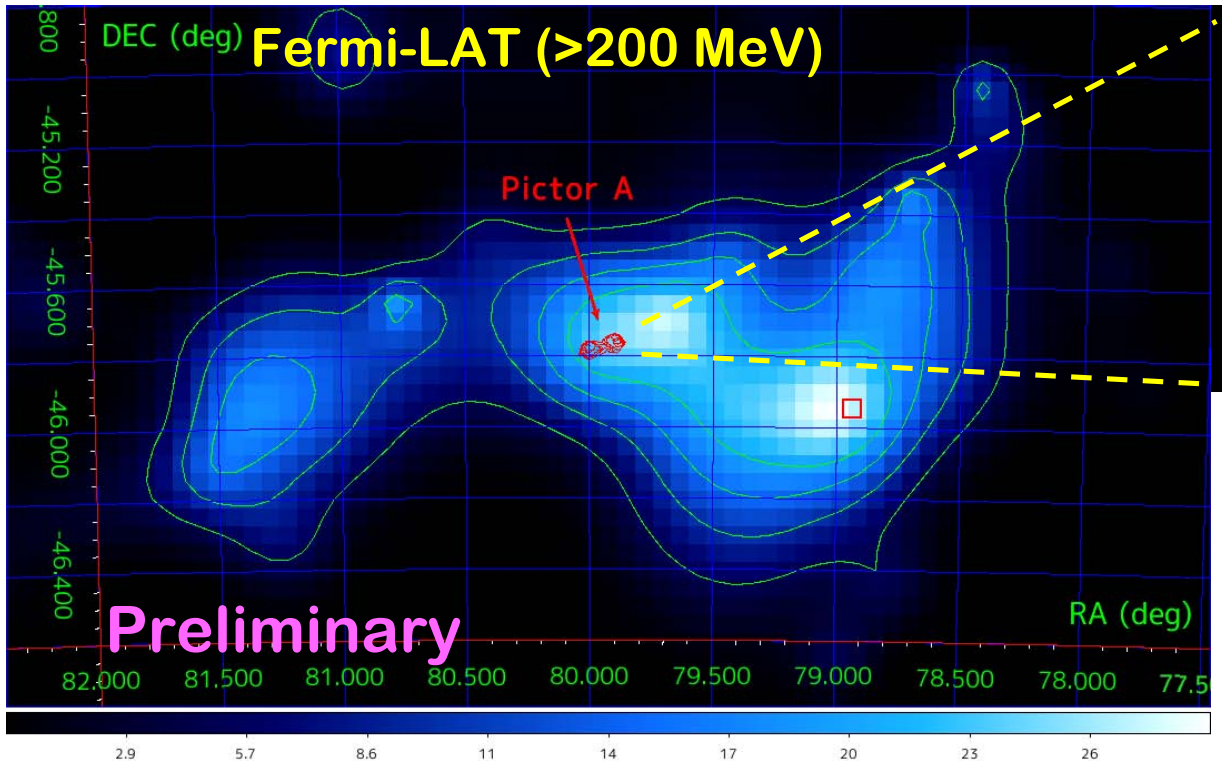
Analysis of 2yr Fermi-LAT data

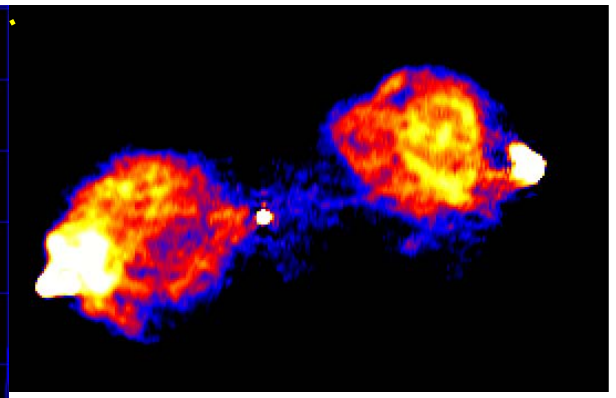




- No statistically significant detection except for 3C111 and 3C120.
- 1/20 of EGRET flux for 3C111. γ-ray emission is most obvious during first 6-month, coinciding with a bright sub-mm flare (Chatterjee+2011)

Pictor A; another candidate

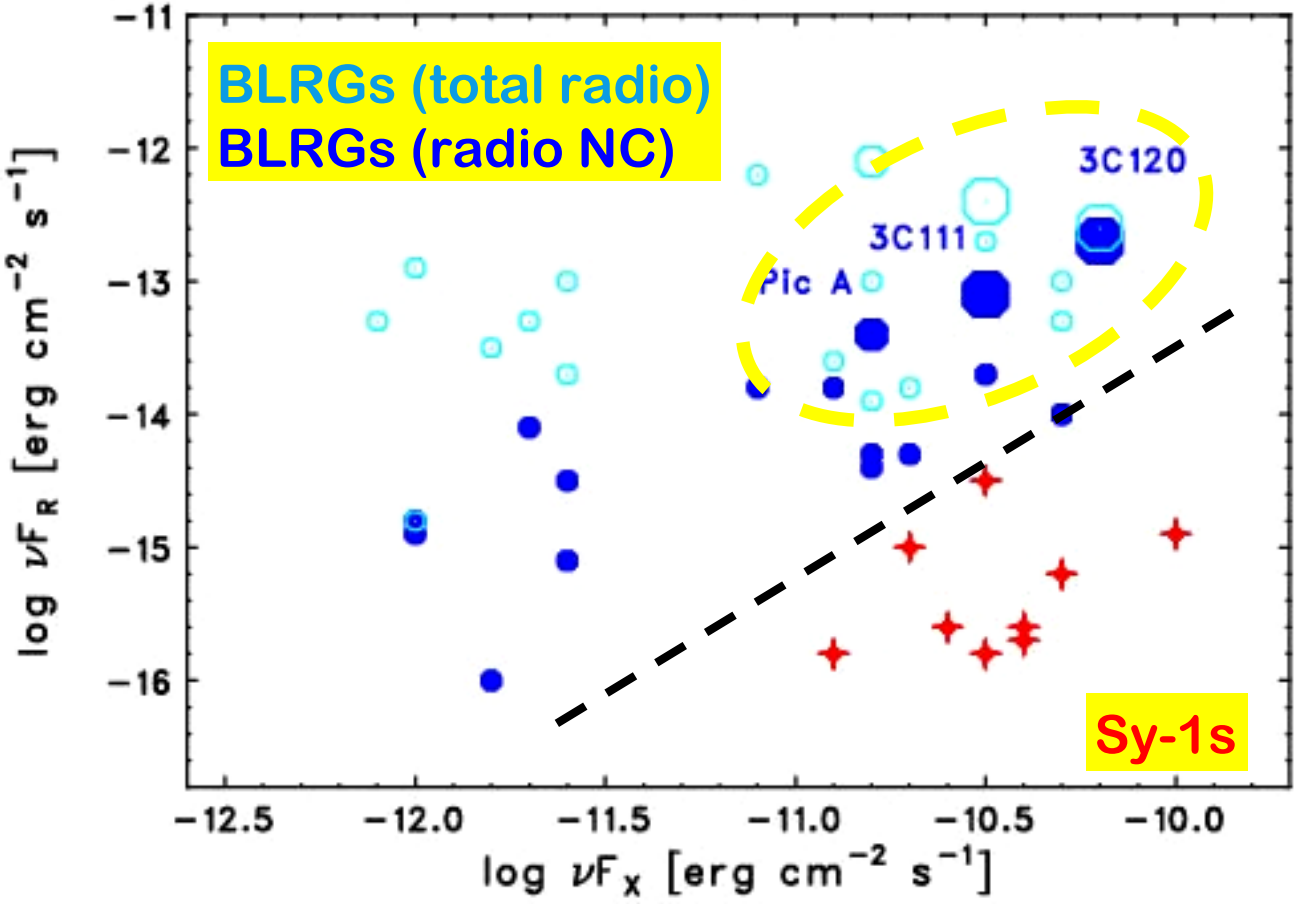




1.4GHz radio image
of Pictor A radio galaxy
(Perley et al. 1997)

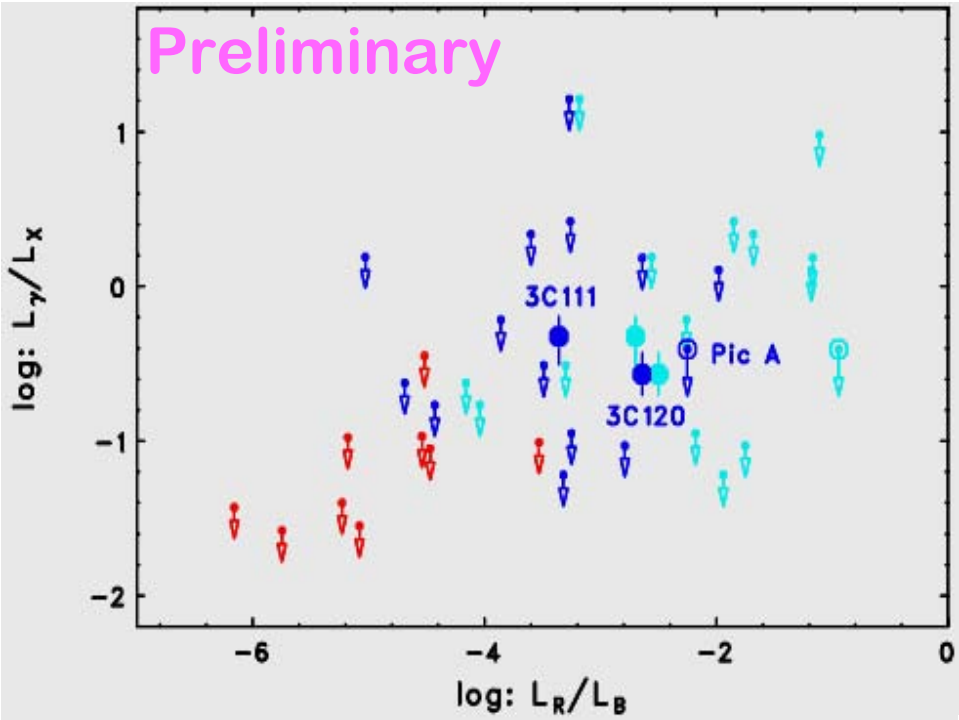
- Fermi-LAT TS map centered on Pictor A, showing the presence of multiple γ-ray peaks in the field. The peak near the center of the map (TS=20) is almost exactly coincident with the position of Pictor A.
- Although not yet detected, formal detection (TS >25) of this source by Fermi-LAT in the near future is quite likely.

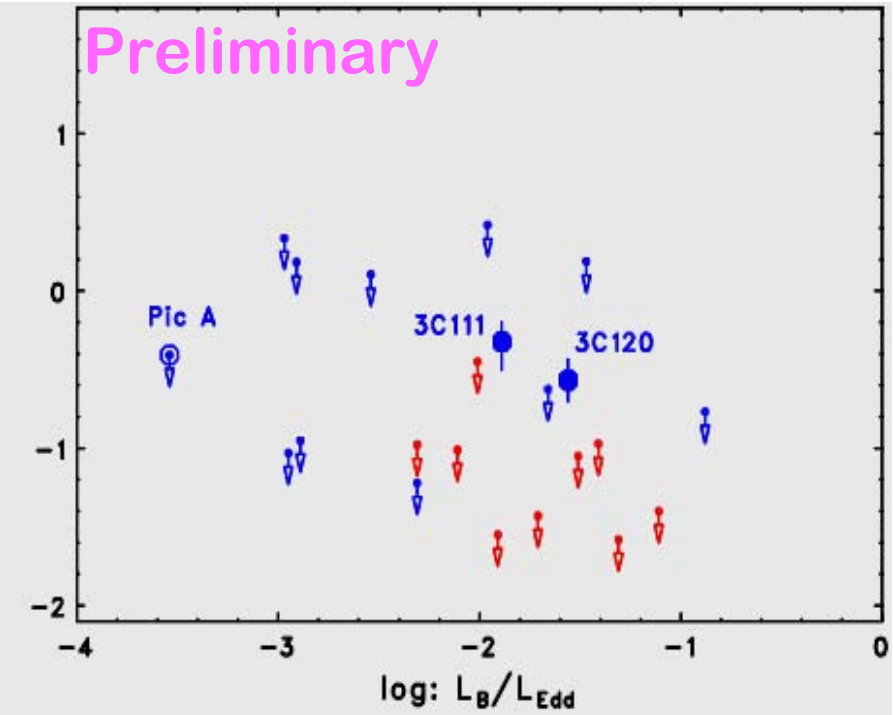
Which BLRGs are detected in GeV ?



- What appears to differentiate 3C111 and 3C120 (and possibly Pictor A) from the sources not yet detected in γ–rays is the strong nuclear flux density in the radio.

Multi-wavelength Diagnostic Planes



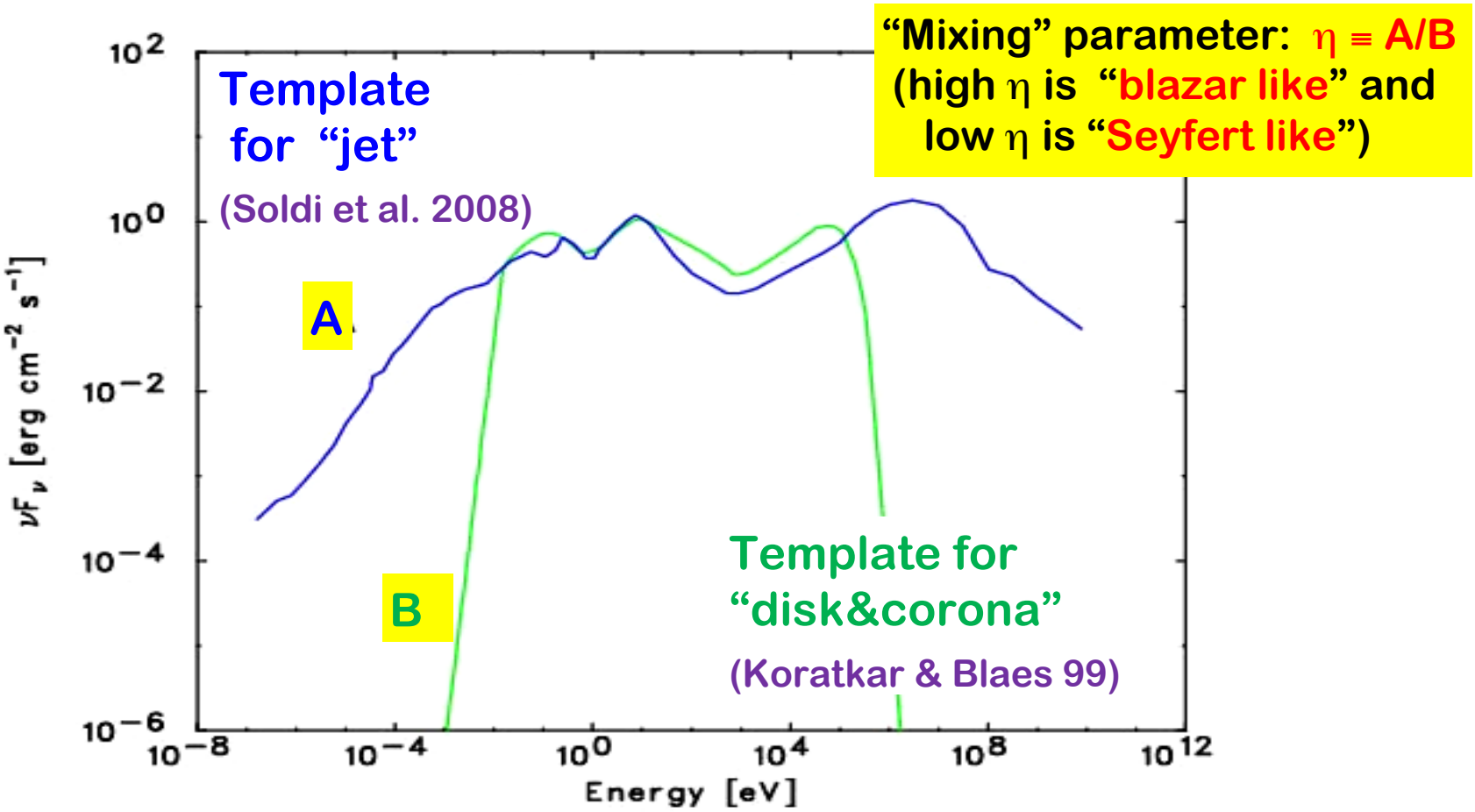


"Radio-loudness" (≈ jet efficiency)

"Eddington Ratio" (≈ accretion rate)

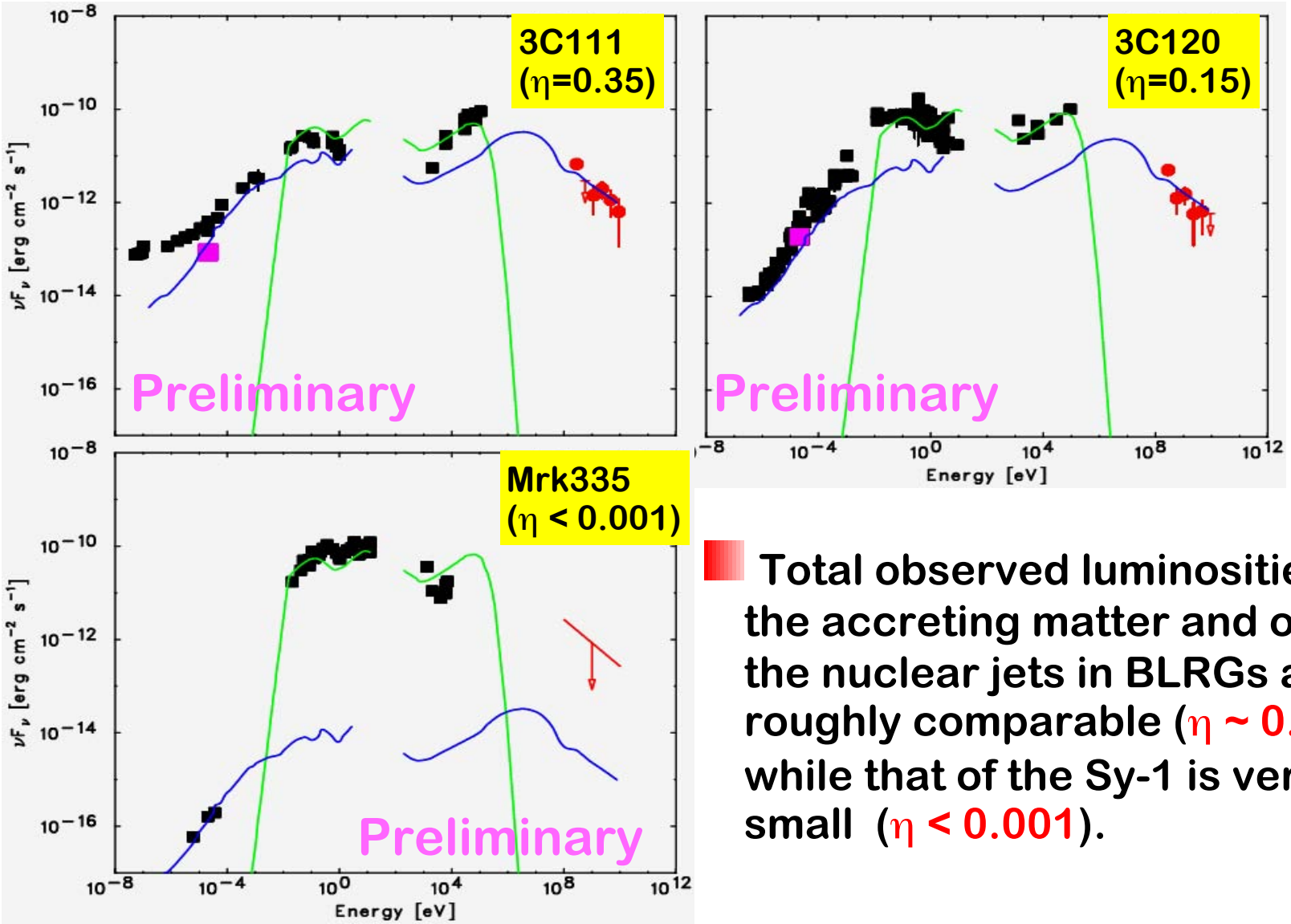
- Brightest GeV sources (3C111, 3C120 & Pictor A) do not stand out in these diagnostic planes. Most important parameter for GeV detection is radio nuclei power/flux!

A "Hybrid" model: jet+disk



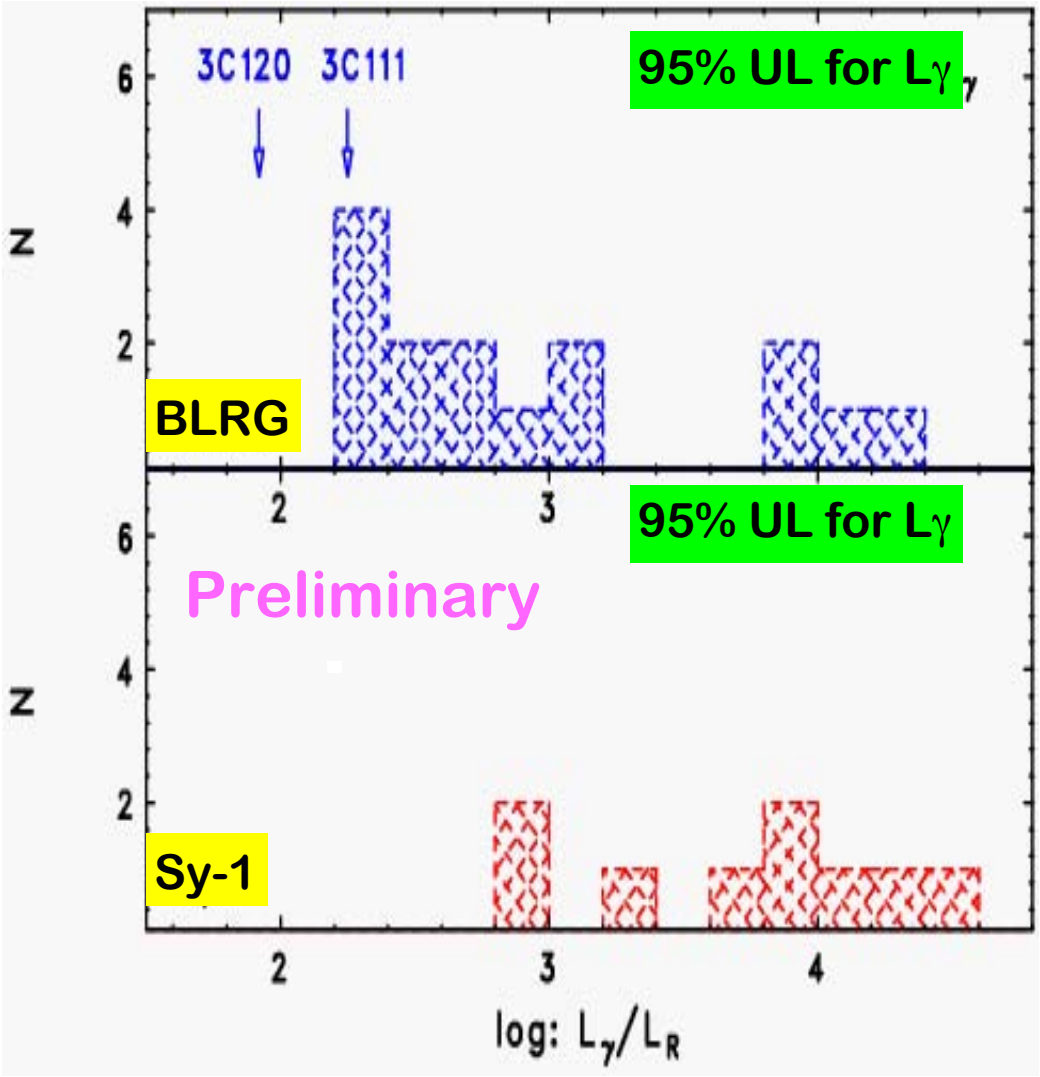
- Using "templates" for a blazar (3C273) and Sy-1 SEDs, we try to disentangle the jet and the accretion disk contributions to the broad-band emission spectra of BLRGs.

Application to SEDs



- Total observed luminosities of the accreting matter and of the nuclear jets in BLRGs are roughly comparable ($\eta \sim 0.1\text{-}1$), while that of the Sy-1 is very small ($\eta < 0.001$).

Future LATdetection; more thought



- The γ-ray-to-radio energy flux ratios for the two BLRGs (and of Pictor A) detected by Fermi LAT are of the order of 100, while the corresponding UL for all other objects are much above this value.
- BLRGs are in principle γ-ray loud, but their detections in γ-rays are at present just limited by the sensitivity of Fermi-LAT.

Conclusion

- We have reported on a detailed investigation of the γ-ray emission from 18 BLRGs in comparison with 9 high-accretion-rate Sy-1s.

- Only two BLRGs, 3C111 and 3C120, are formally detected, yet relatively high TS of 20 was found at the position of Pictor A.

- These three BLRGs are at the same time have the brightest radio nucleus, suggesting that GeV emission of BLRGs is dominated by the innermost part of their jets, and is therefore "blazar-like".

- Application to a "hybrid model" suggest total observed luminosities of accreting matter and of the nuclear jet are roughly comparable ($\eta \sim 0.1$-1) for BLRGs, as expected in a framework of AGN unification.