GeV-loud電波銀河の高エネルギー放射の系統的性質と種族研究

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Radio galaxies established as a gamma-ray source

thought to be a parent population of blazars

more numerous than blazars

Open Questions for GeV-loud radio galaxies …

Luminosity Function (LF) ? 2020秋季年会 Fukazawa+

Contribution to Extragalactic gamma-ray bgd ? .. 同上

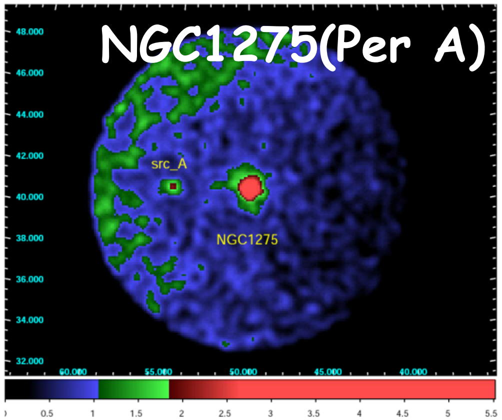
How about SED is ?

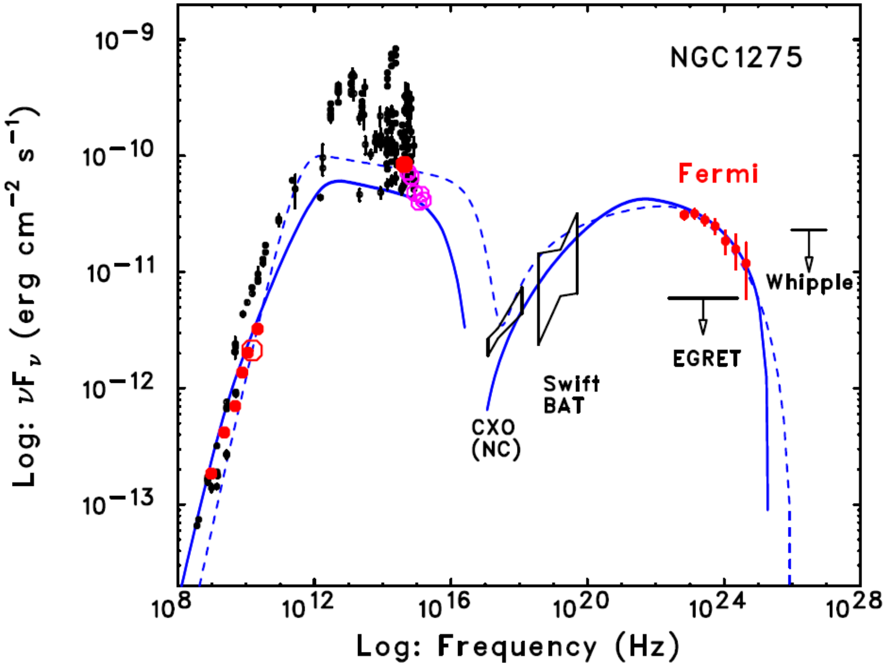
Population ?

FR-I rich ? FR-II rich ?

GeV-loud vs GeV-quiet ?

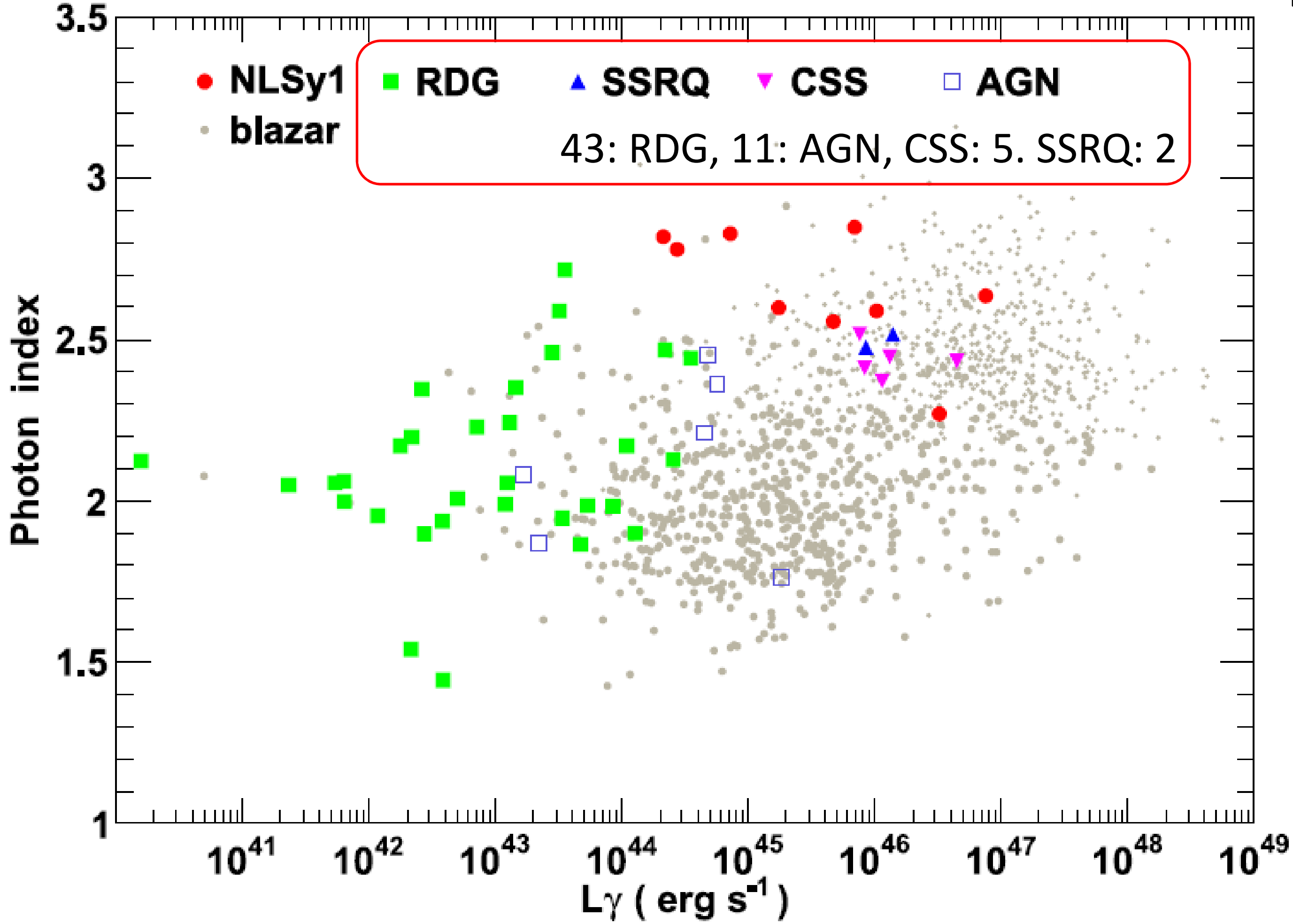
Relation with Blazars ?





4th Fermi Catalog (4FGL-DR2): Misaligned AGN (61 galaxies)

From 4LAC paper

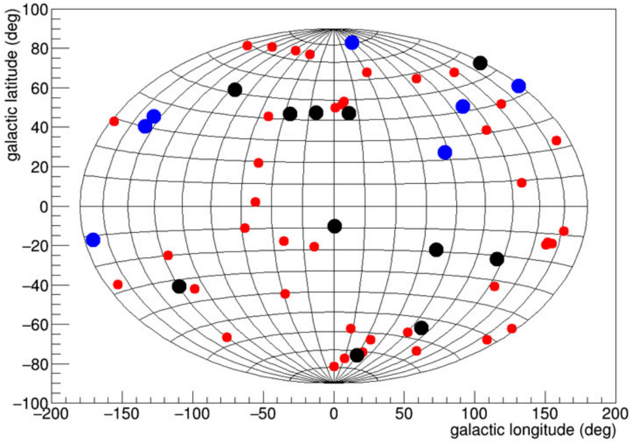


X-ray data

We searched for X-ray data with a priority order of XMM-Newton, Chandra, Swift, RASS. 8 bright objects are from Fukazawa+15 Suzaku results..

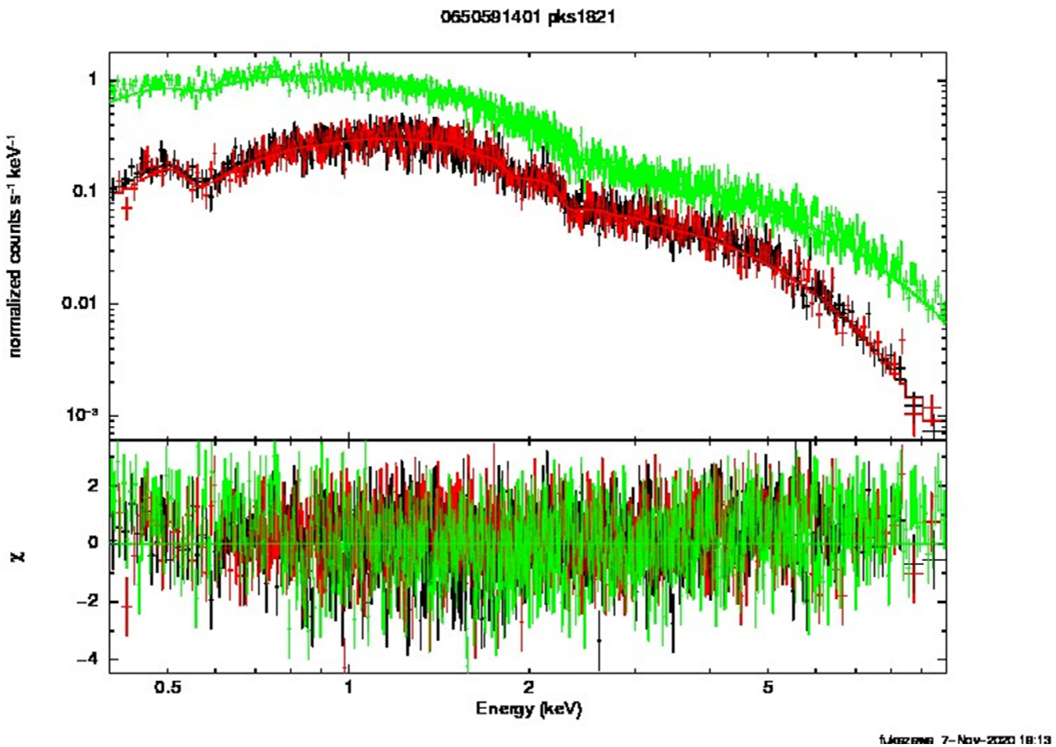
XMM-Newton	20
Chandra	14
Swift	9
NuSTAR	1
RASS	5
XMM slew	1
Suzaku	7
No X-ray data	4

RDG
AGN
CSS/SSRQ



Fitted with powerlaw to obain a photon index and flux.

PKS 1821--327

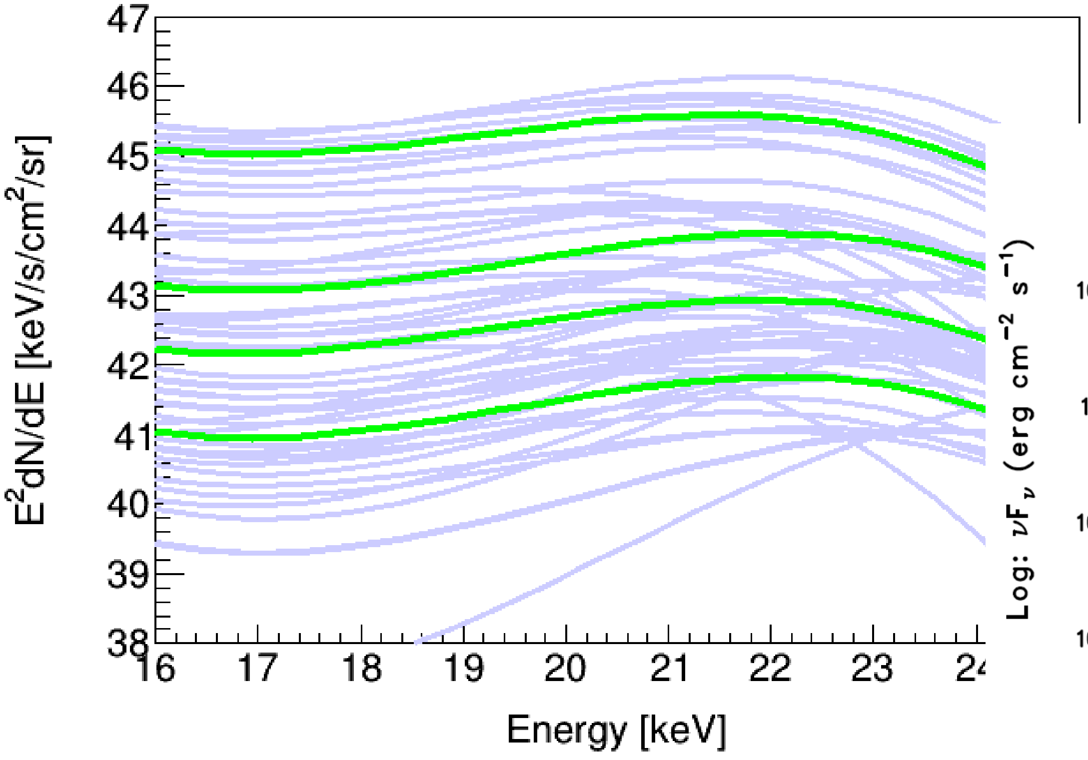


SED analysis from X-ray to GeV gamma-ray

Fitted X-ray and gamma-ray spectra with 4-th polynomial function.

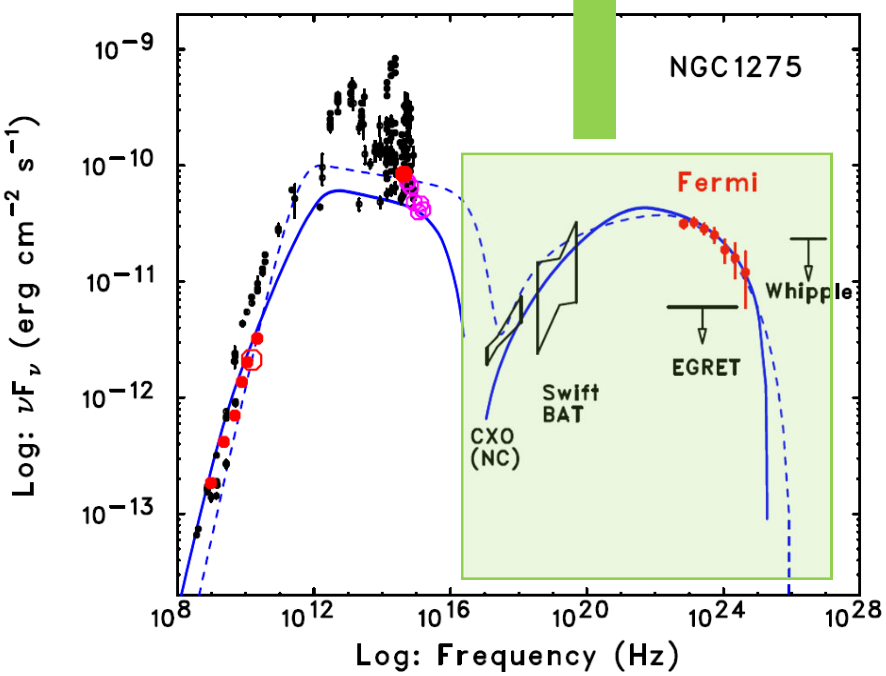
Plot of obtained SED curves for each galaxy

Average SEDs of 4 luminosity regimes



High energy (H.E.) emission

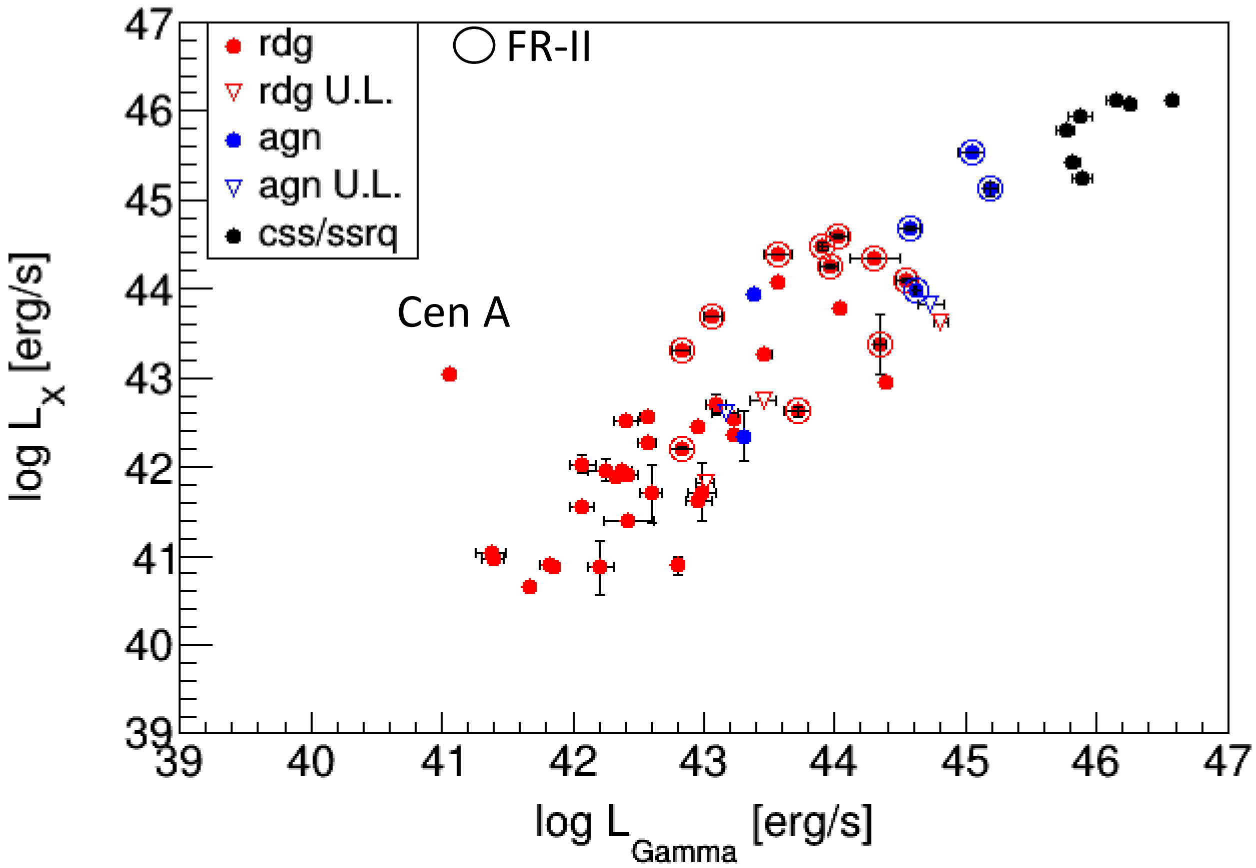
Jet, disk/corona



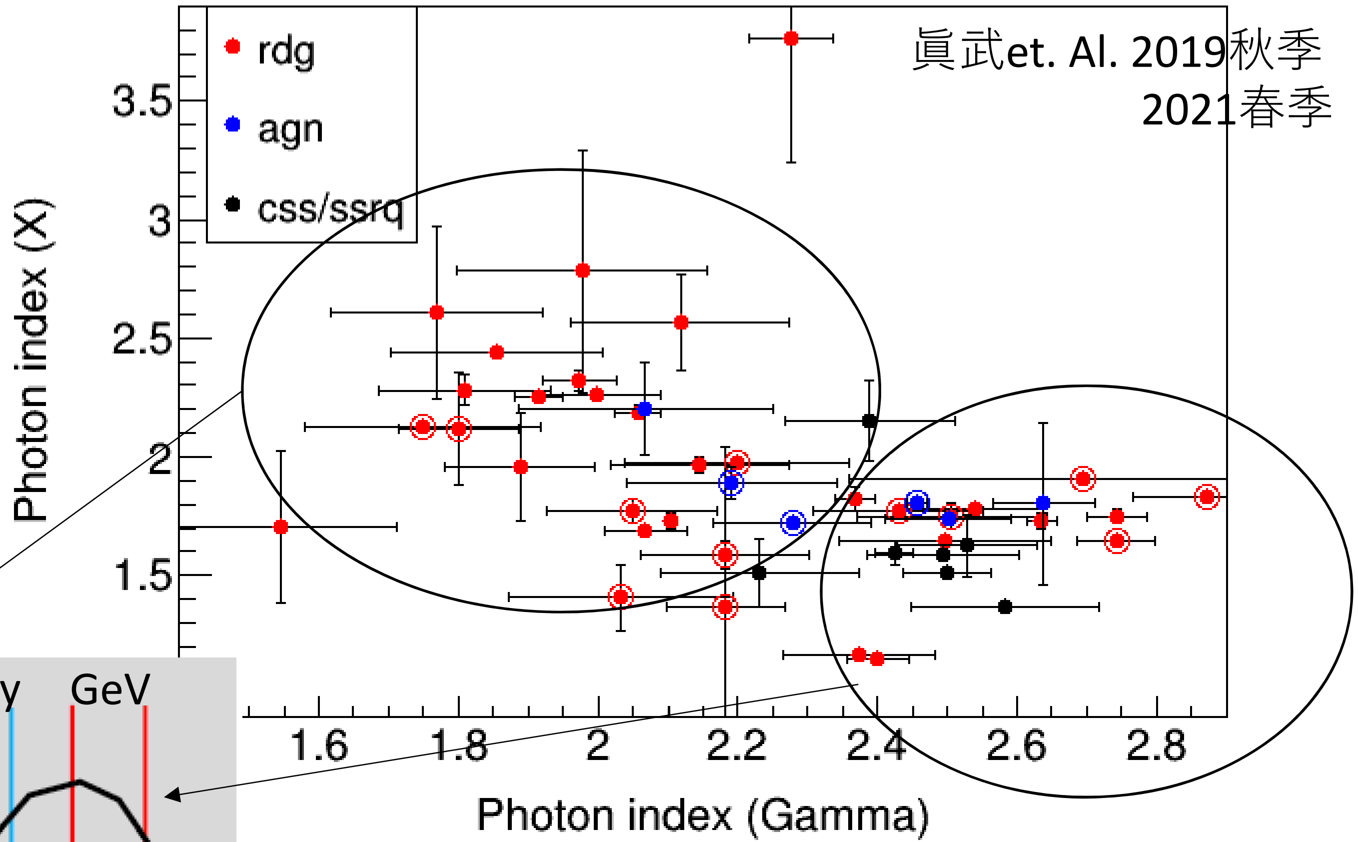
Correlation of luminosity between X-ray and GeV.

X-ray L iroughly correlates with GeV L.

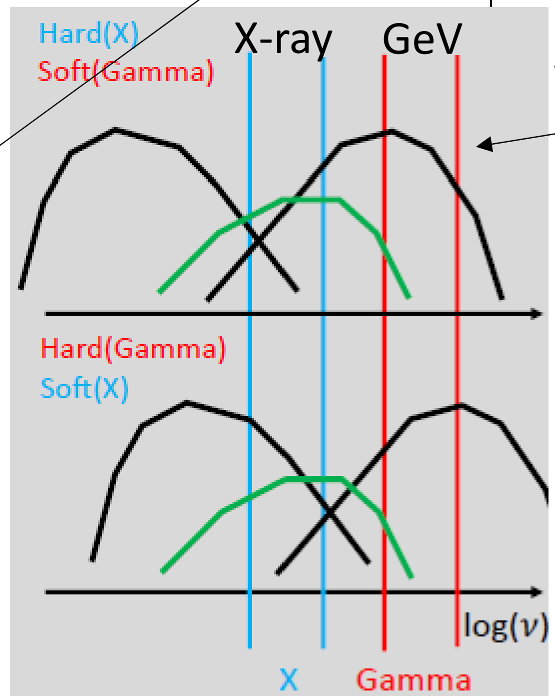
FR-II is not always bright.
CSS/SSRQ are the brightest in both X-ray and GeV.



Correlation of photon index between X-ray and GeV



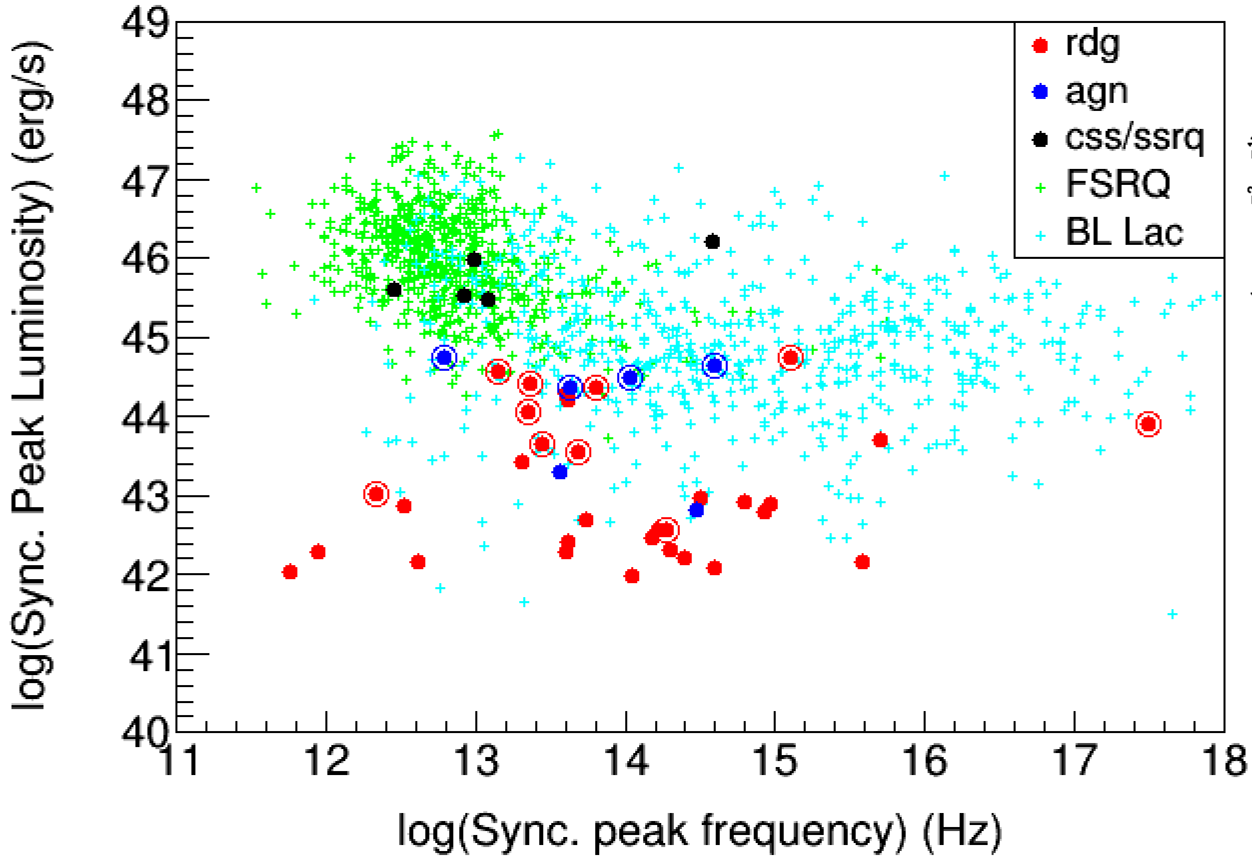
SED

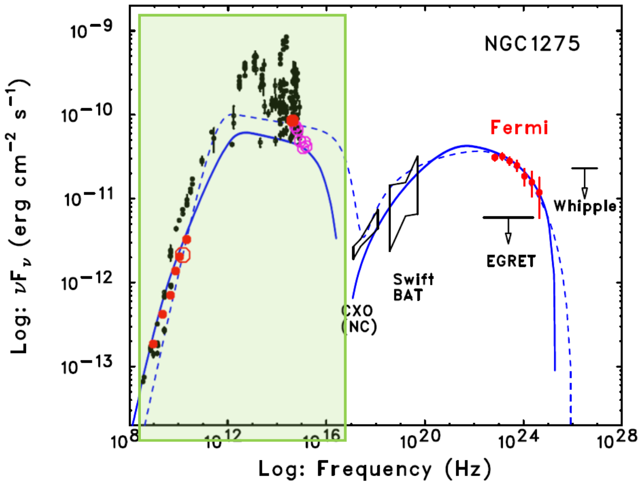


Synchrotron Peak (from 4LAC(-DR2)

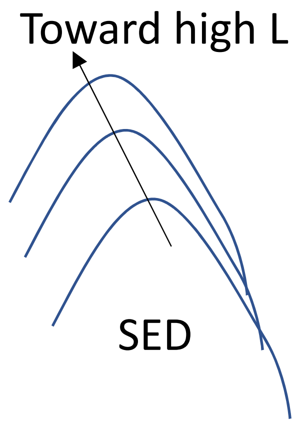
Wide dist. of peak frequency, but blazar seq. is not seen.

Note that SED in IR, Opt, and X-ray could be contaminated by non-jet emissions.

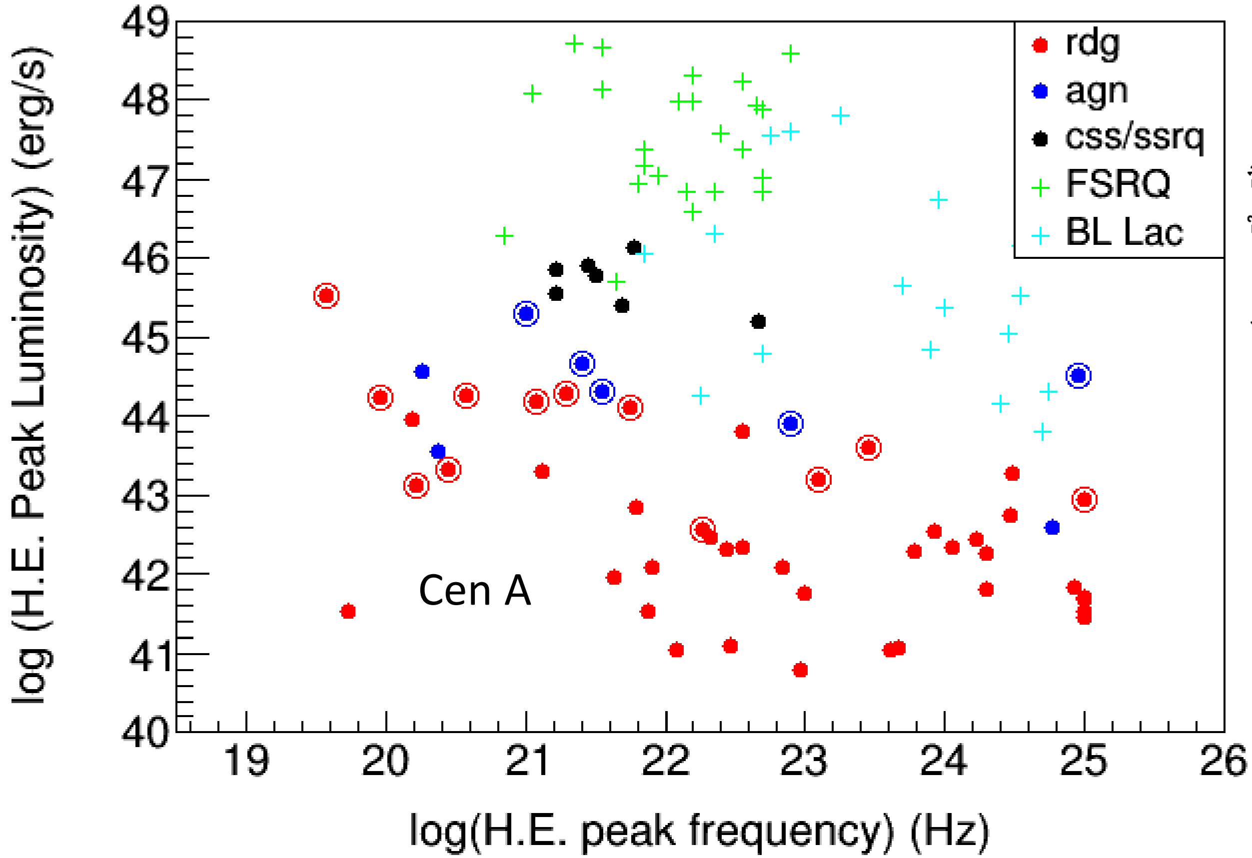


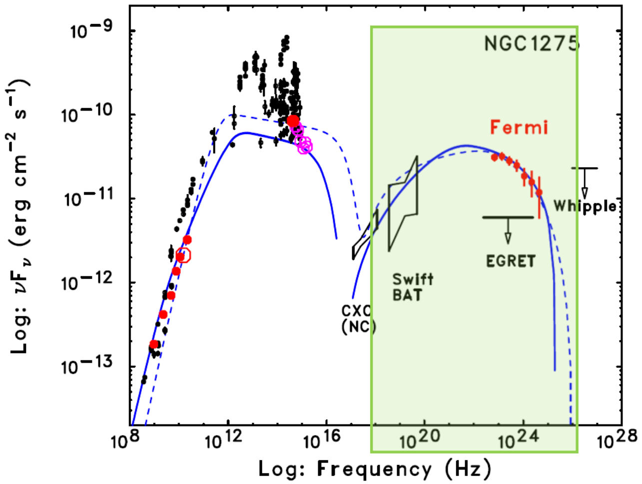


H.E. component peak (from SED fit)



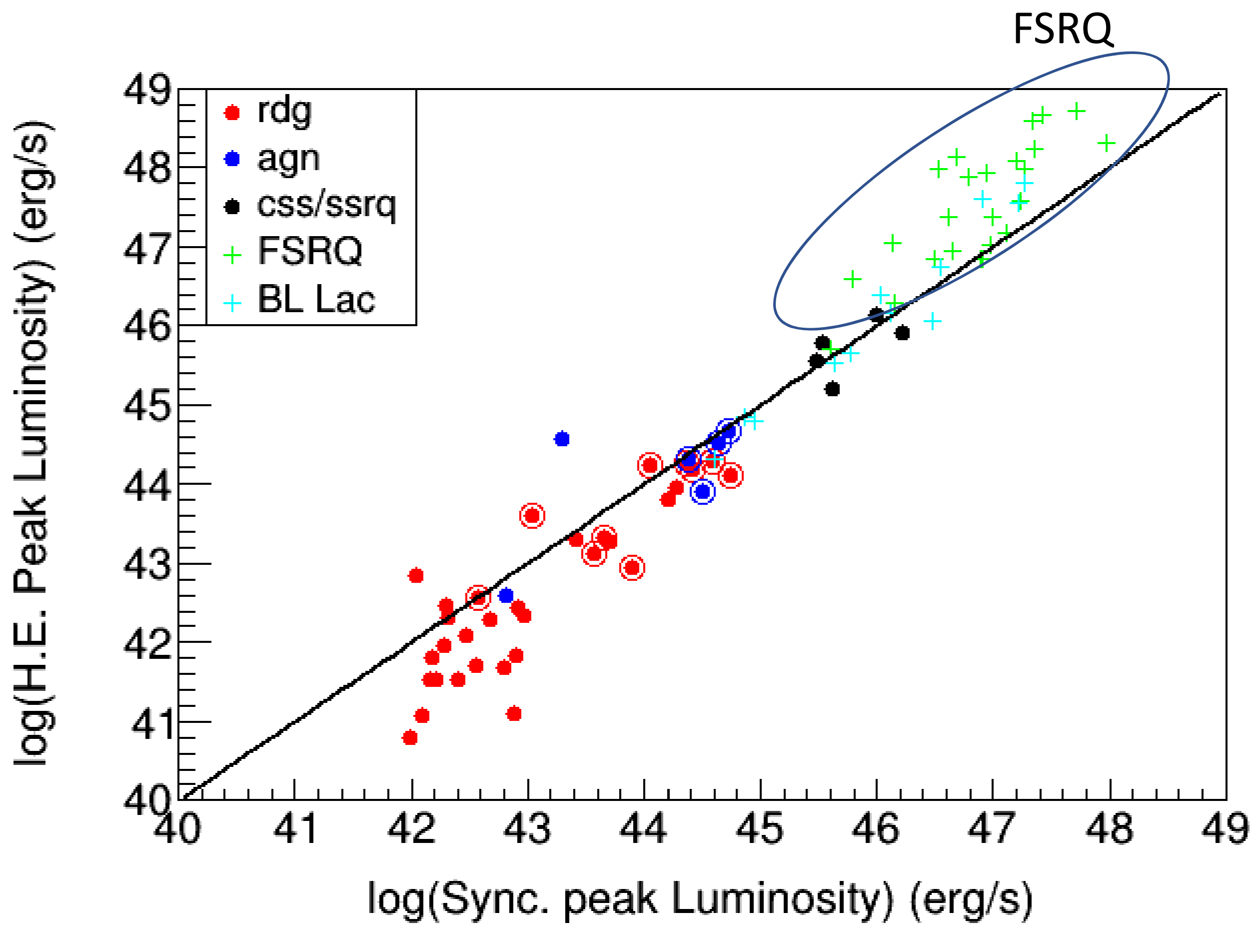
Wide dist. of peak frequency, and blazar-like seq. is seen.



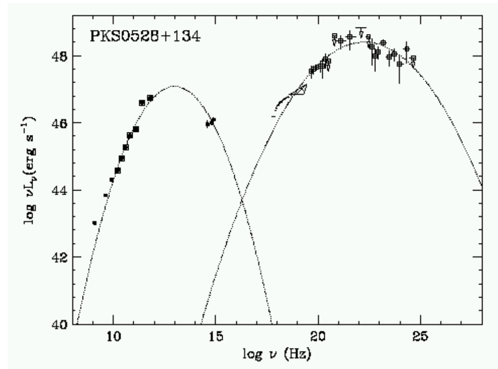


Correlation of luminosity between Sync-peak and H.E. peak.

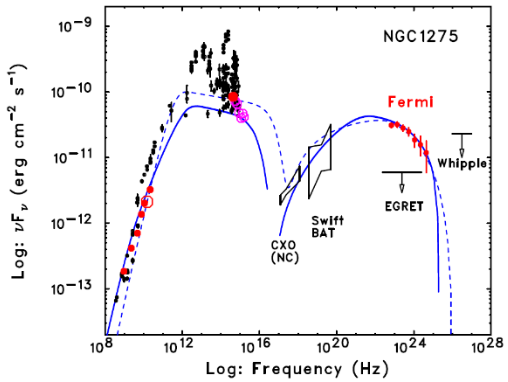
Compton dominance of RGs is similar to or less than that of BL Lac.



FSRQ



Radio Galaxy



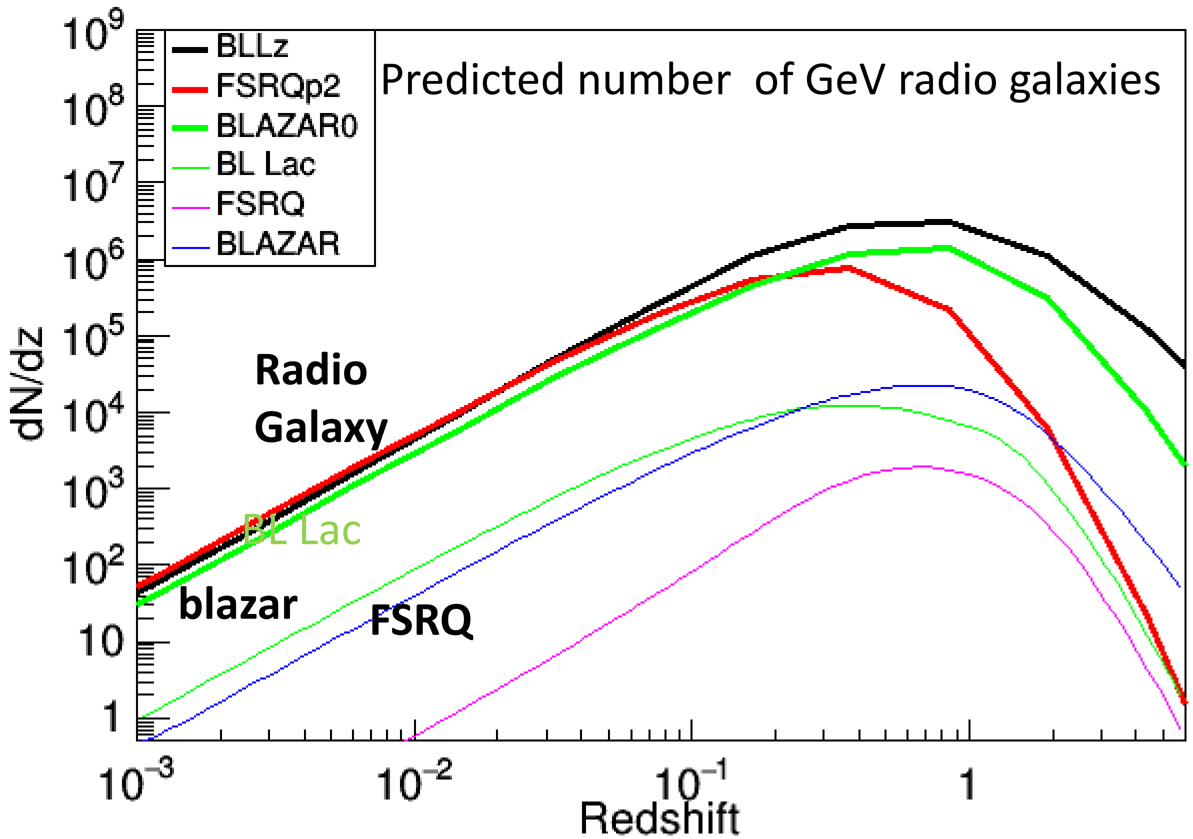
Population (1)

GeV radio galaxies are 10—30 times as numerous as blazars.

←→ Viewing angle of balzars is 0-10deg.

Only 10% of 2 Jy flux-limited radio-sample RG (Mingo+14) are detected in GeV.
(c.f. 榧木講演)

Considering a beaming effect, only a small fraction of RGs with a viewing angle <24deg are seen in GeV ? (Inoue 11)



Population (2)

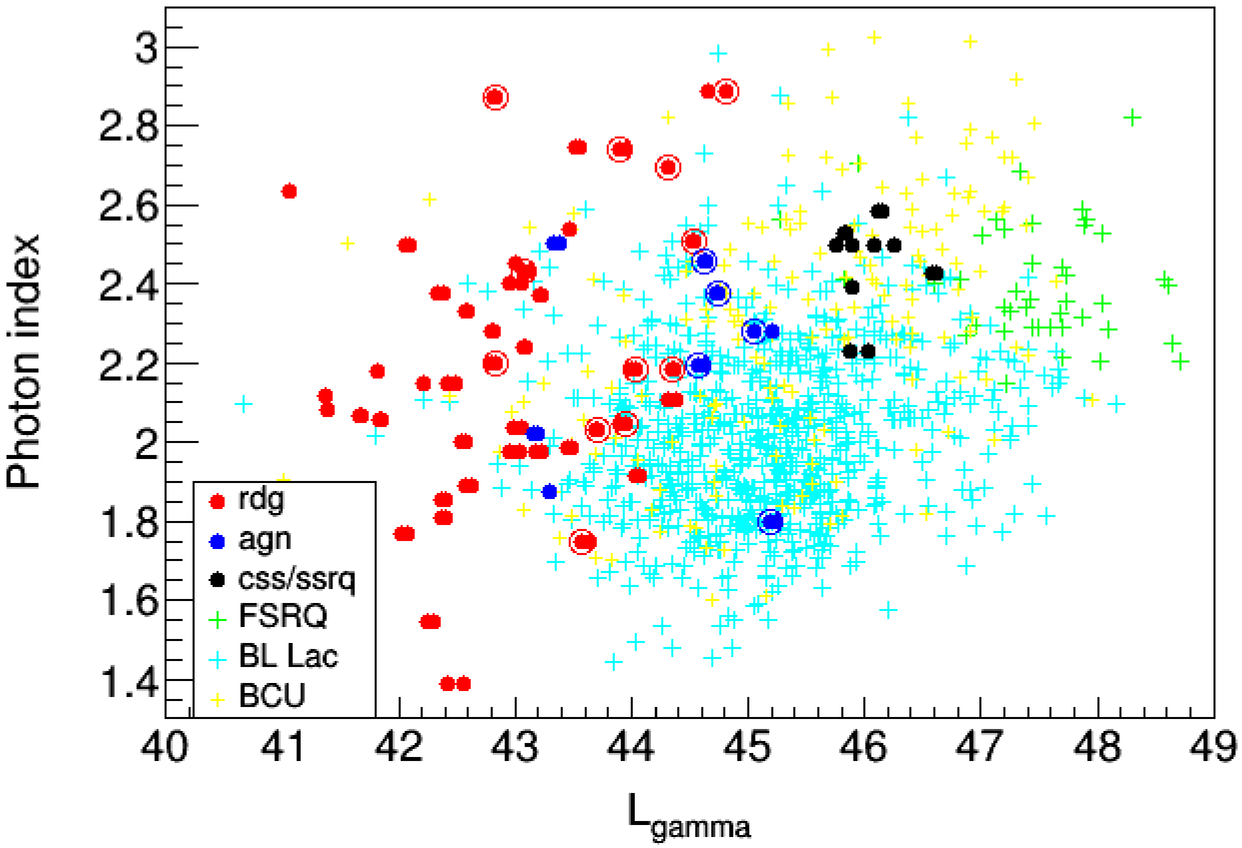
FR-I / FR-II ←→ BL Lac / FSRQ

Blazar seq of H.E. emission component is common.

No FR-II with as large Compton dominance can be due to difference of

“. beaming pattern between external Compton and SSC (Finke+13).

Some FR-Iis may correspond to BL Lac (LBL)?



Population (3)

35 FR-I vs 17 FR-II in GeV …… **FR-IIs are lacking.**

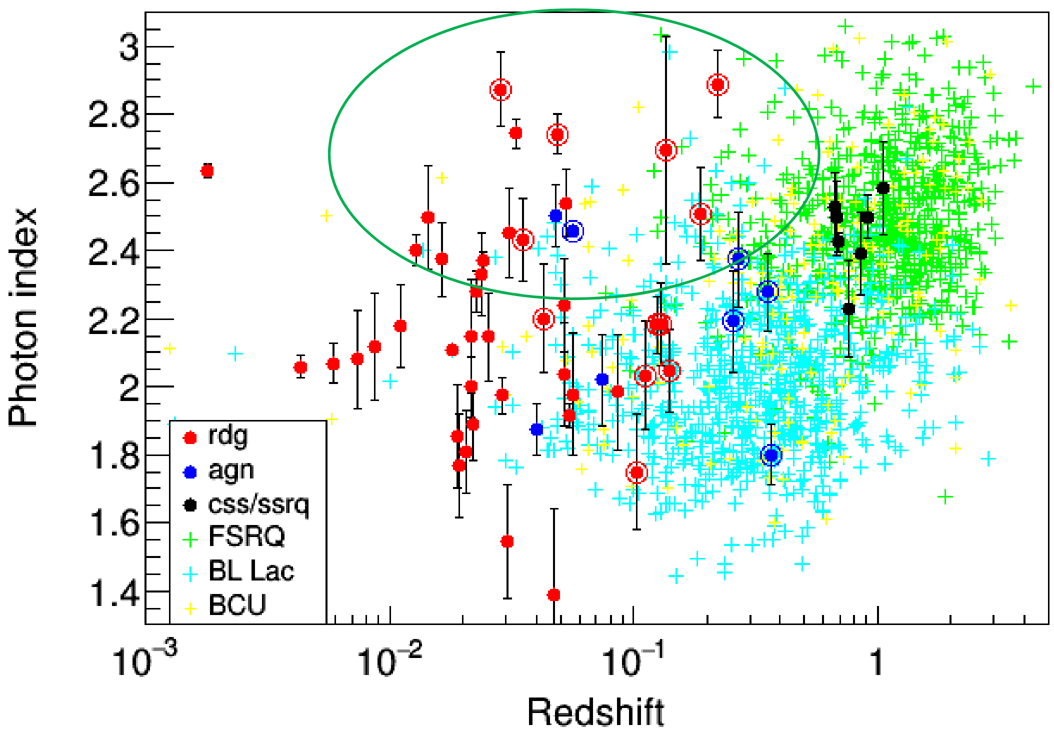
6 FR-I vs 33 FR-II in radio flux-limited (Dicken+18).

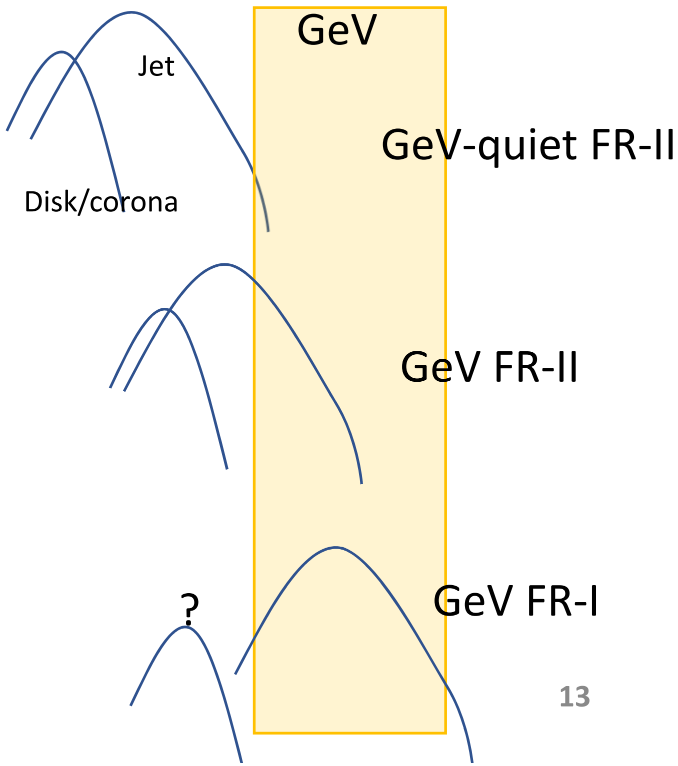
80% of X-ray RGs are FR-II (80%) (Rusinek+20).

H.E. component peak freq. is lower for FR-II. -→ soft GeV spectrum

SED of many FR-II could not reach GeV.

Beaming is more significant for FR-II while FR-I is less due to structured jet.

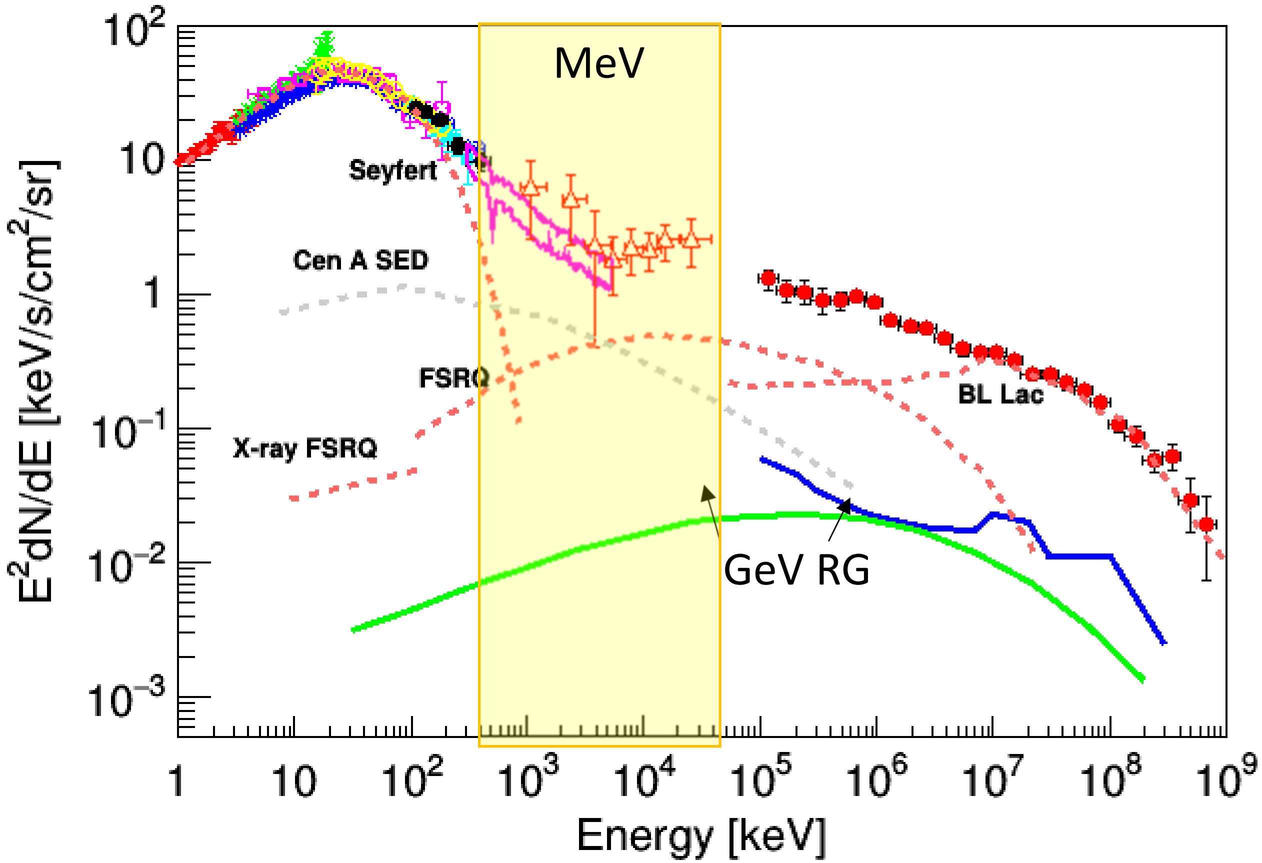




Population (4)

Many hidden FR-Iis could be there in MeV.
7-10% of BAT AGN is RG (Panessa+16, Gupta+18) → 7-10% contribution of RG to CXB.
If such hidden RGs have a Cen-A like SED, contribution to MeV EGB could be comparable to FRSQ

Future MeV mission (e.g. AMEGO) are important.



Conclusion

GeV-loud RG has a blazar-like Sequence on H.E. SED.

GeV-loud RG is a small part of radio-loud RG; only beamed ones are seen in GeV.

FR-I/II vs BL Lac/FSRQ correspondence is consistent with our results.

FR-II is lacking in GeV; H.E. SED peak freq. is lower.
Many GeV-undetected FR-Iis are there.
Possible significant contribution to MeV gamma-ray background.