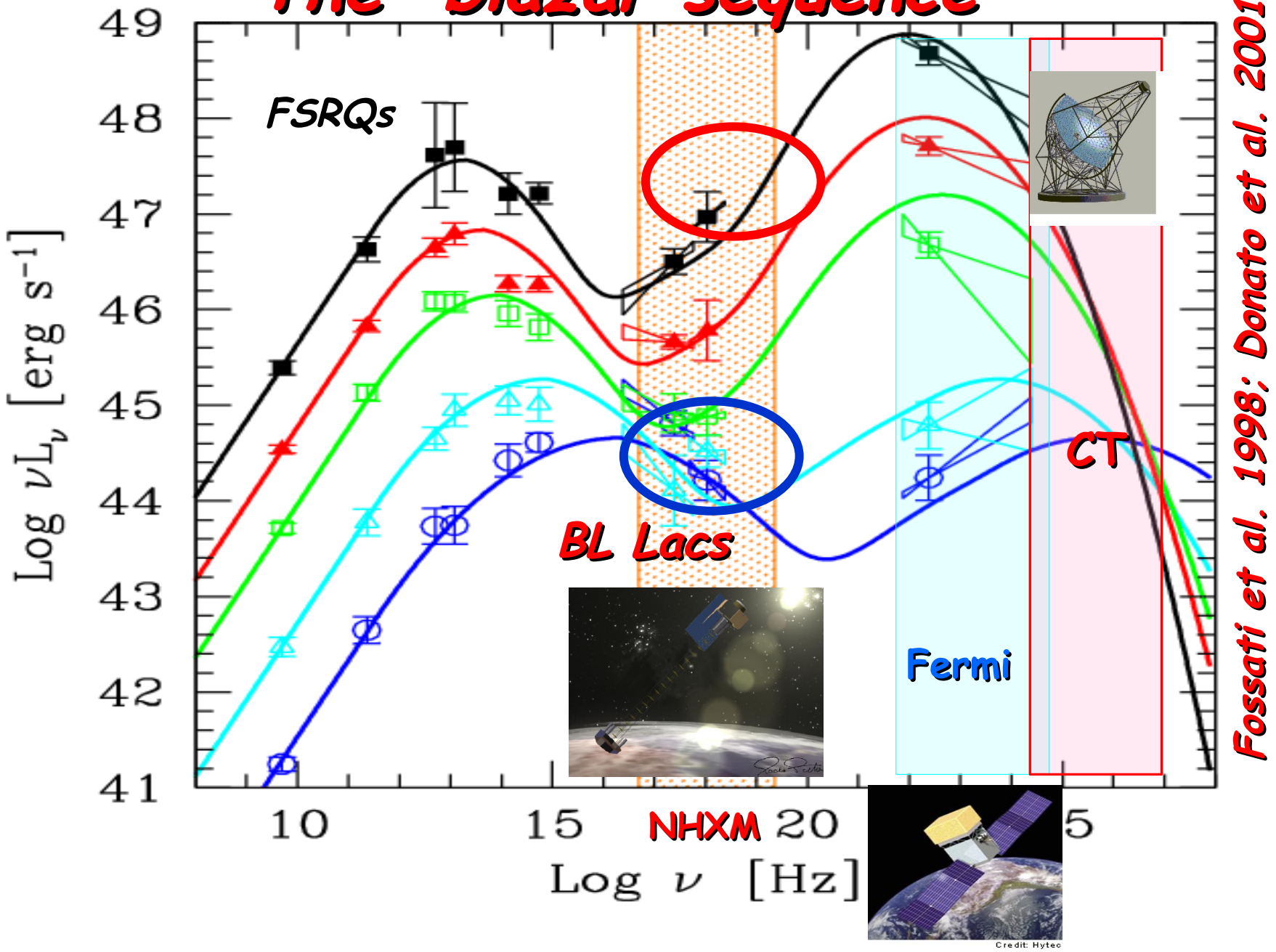
Chasing the heaviest black holes of jetted AGNs

Gabriele Ghisellini

with

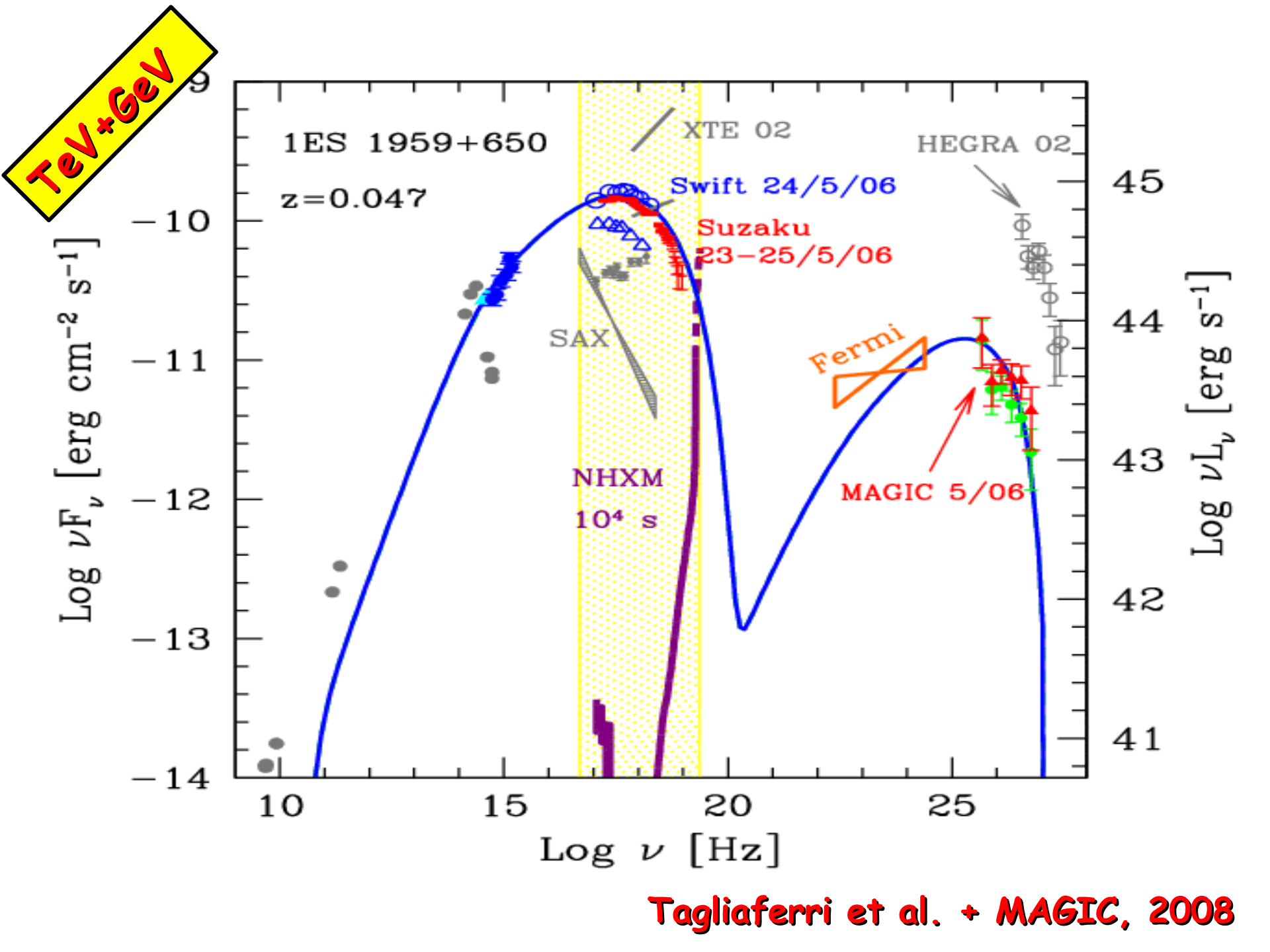
A. Celotti, R. Della Ceca,
L. Foschini, G. Ghirlanda,
F. Haardt, L. Maraschi,
G. Tagliaferri, F. Tavecchio,
M. Volonteri

The "blazar sequence"



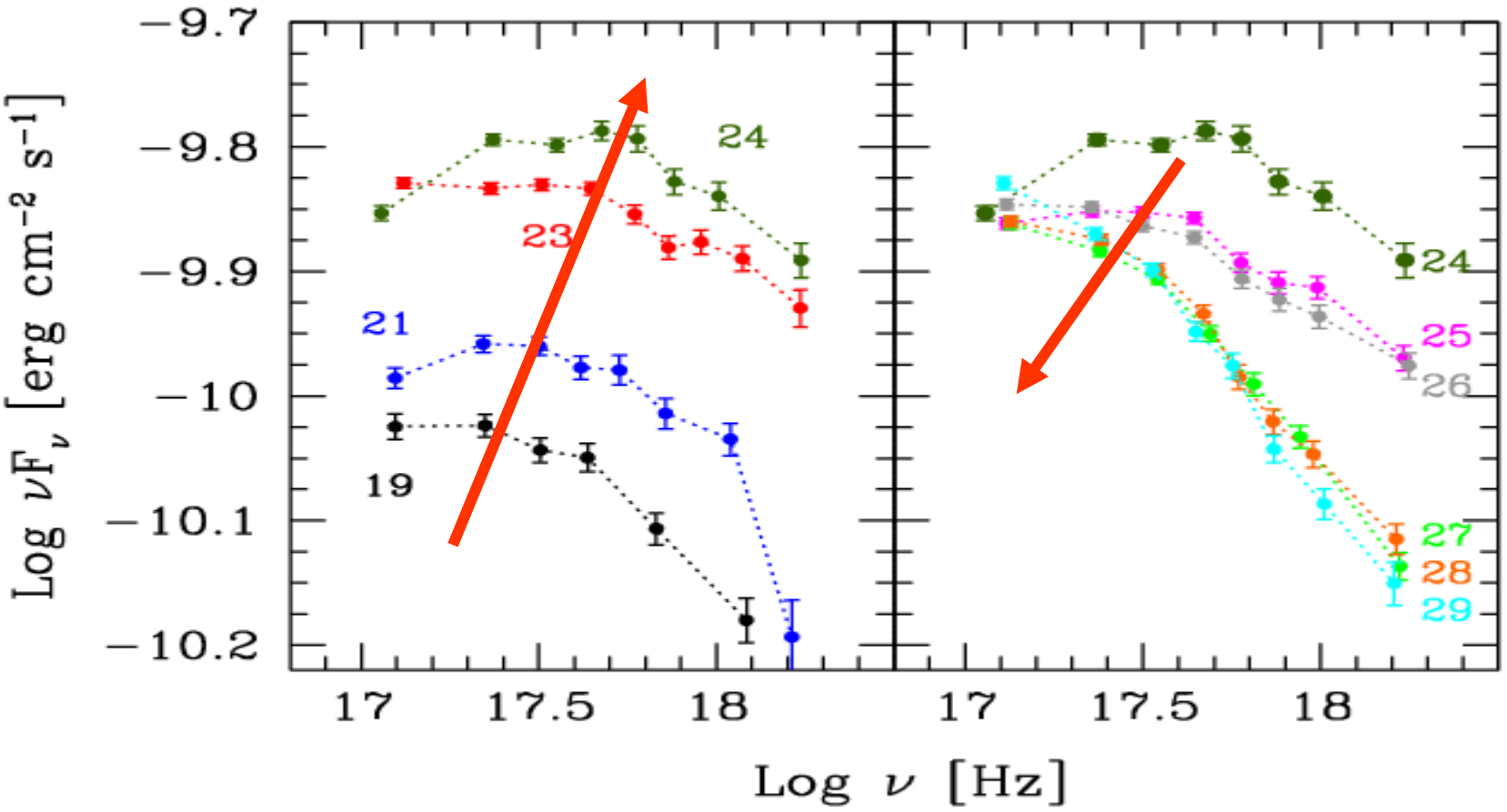
Fossati et al. 1998; Donato et al. 2001

TeV BL Lacs



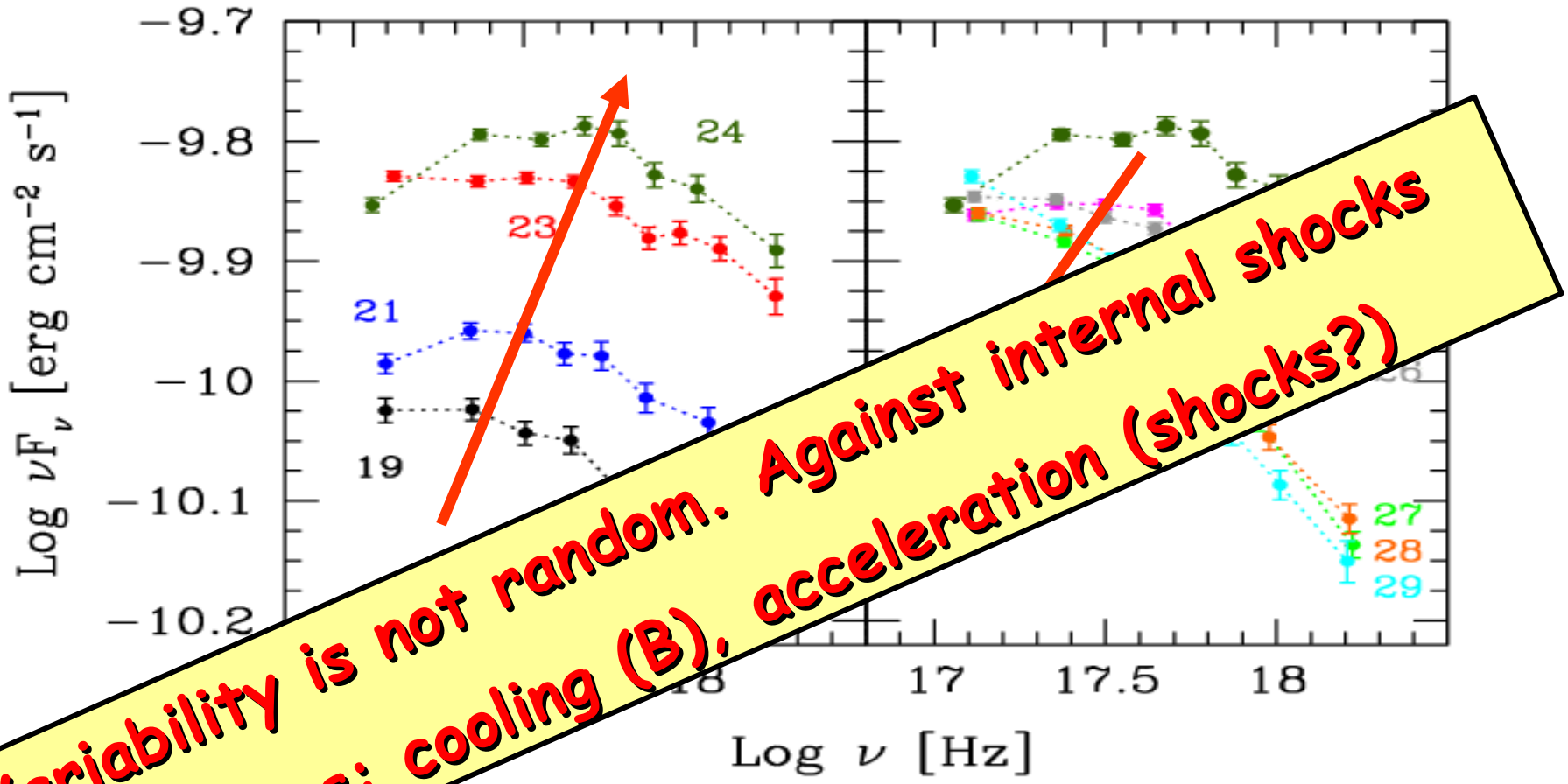
Tagliaferri et al. + MAGIC, 2008

May 2006: Swift snapshots



Tagliaferri et al. + MAGIC, 2008

May 2006: Swift snapshots

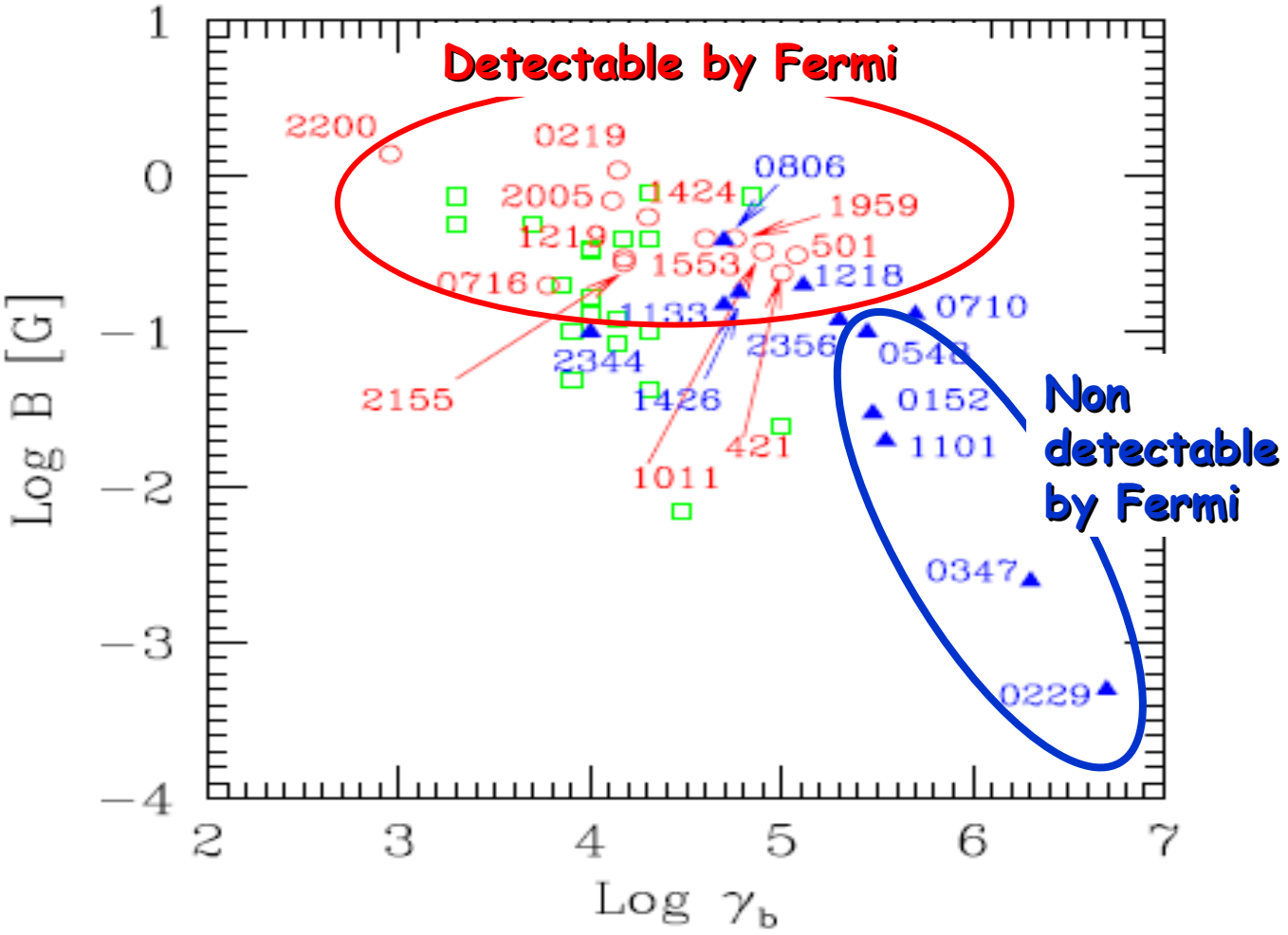


Variability is not random. Against internal shocks

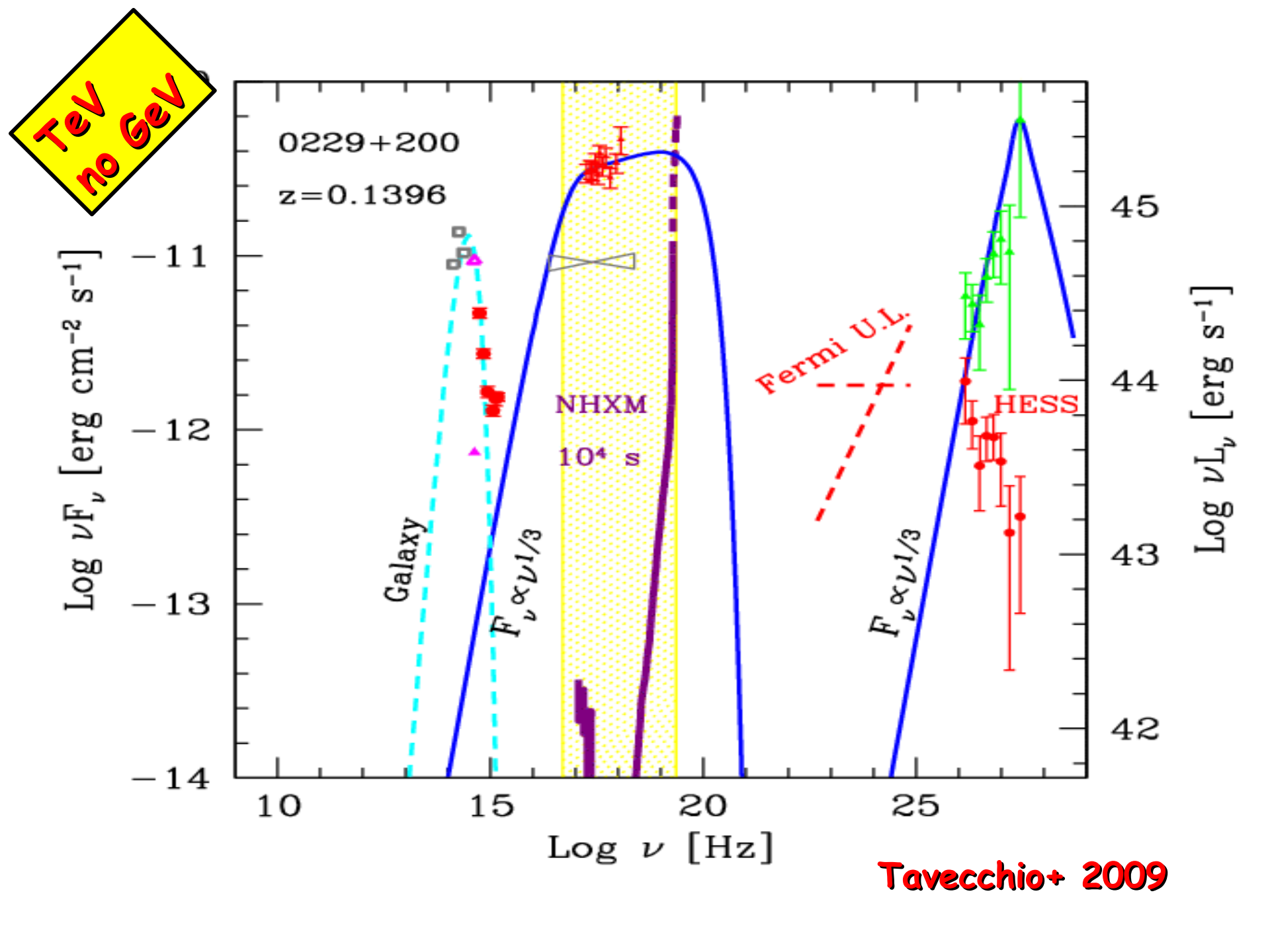
Lag-Delays: cooling (B), acceleration (shocks?)

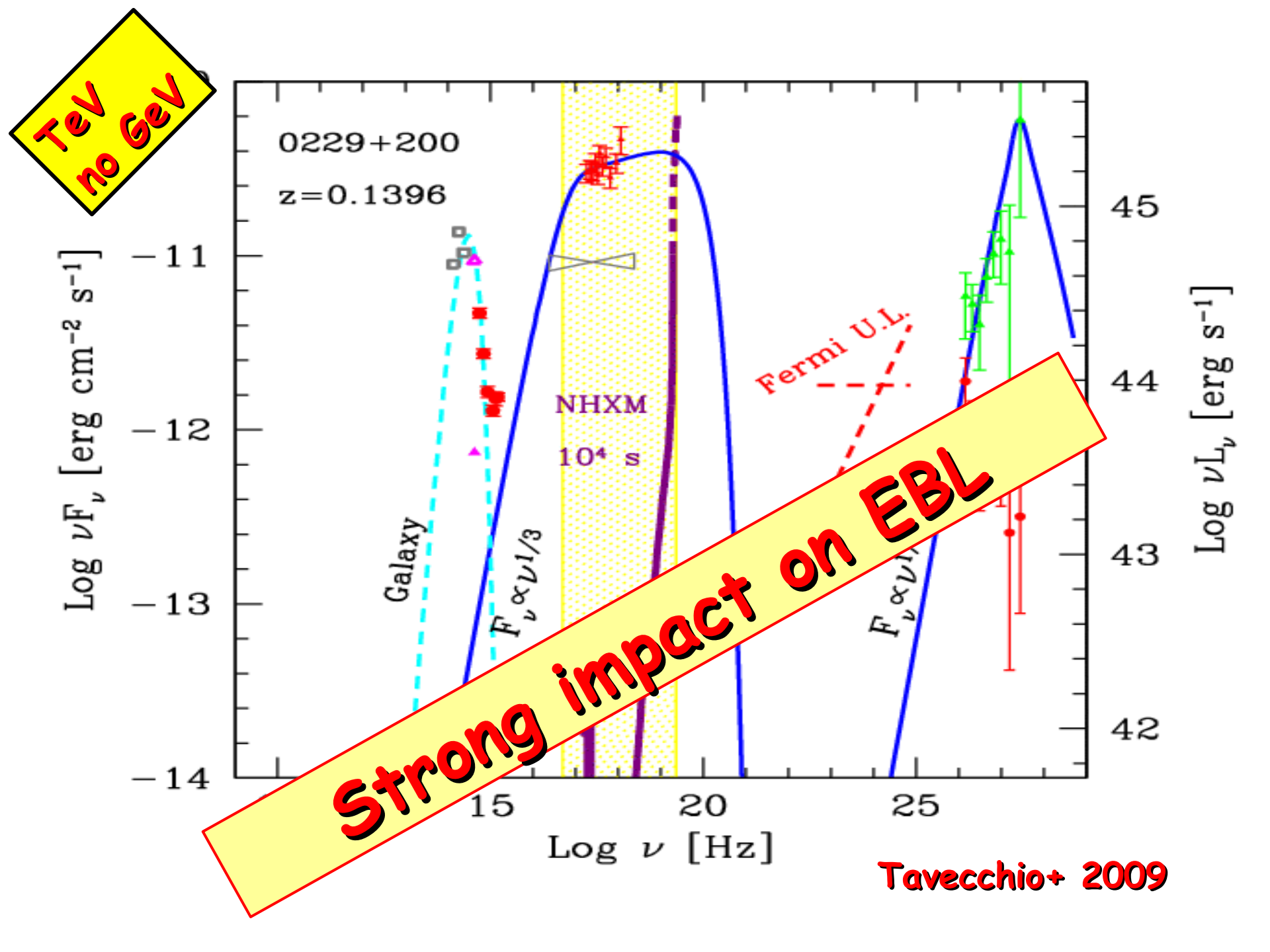
Tagliaferri et al. + MAGIC, 2008

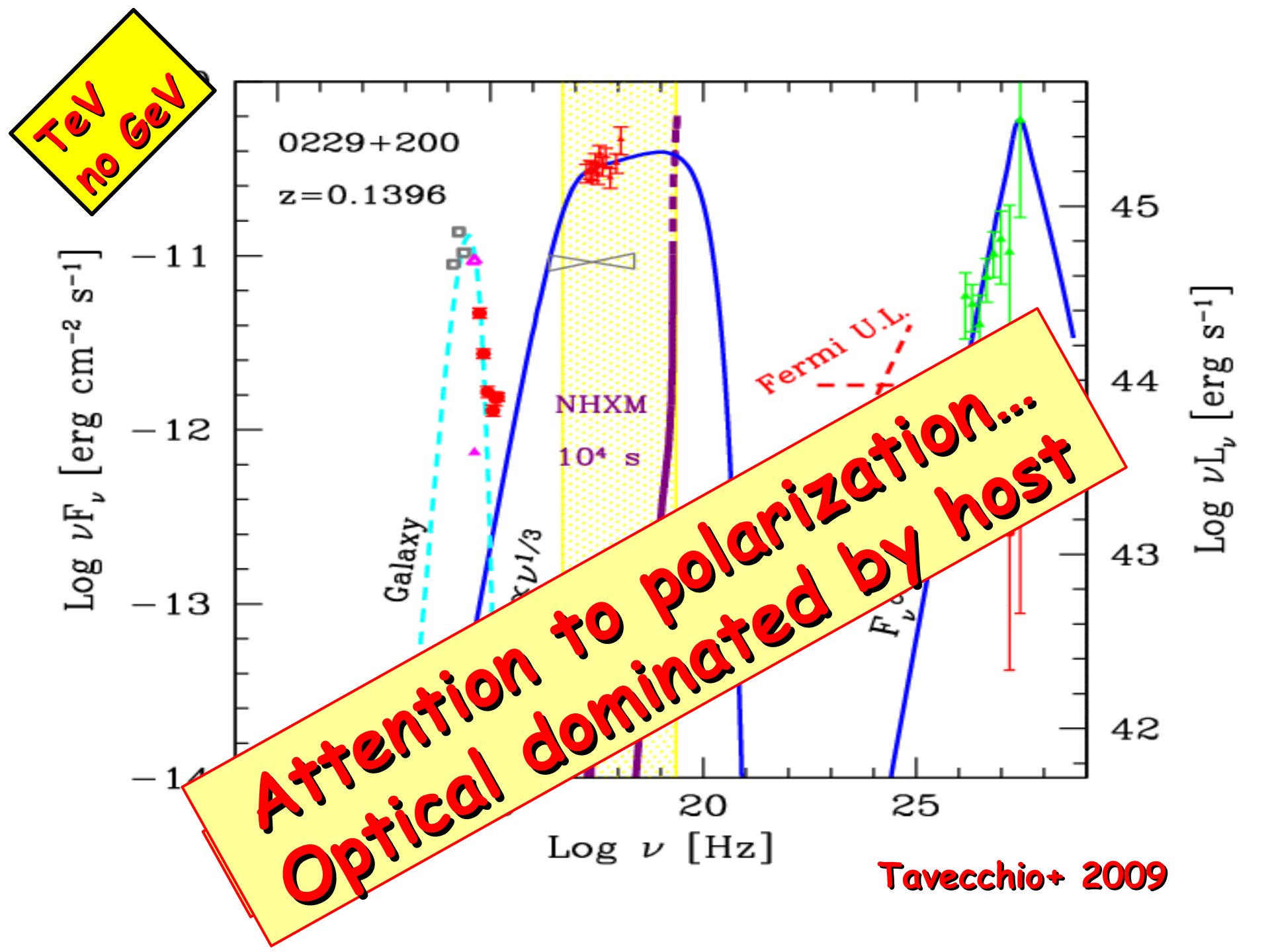
Strange TeV BL Lacs



Tavecchio+ 2009

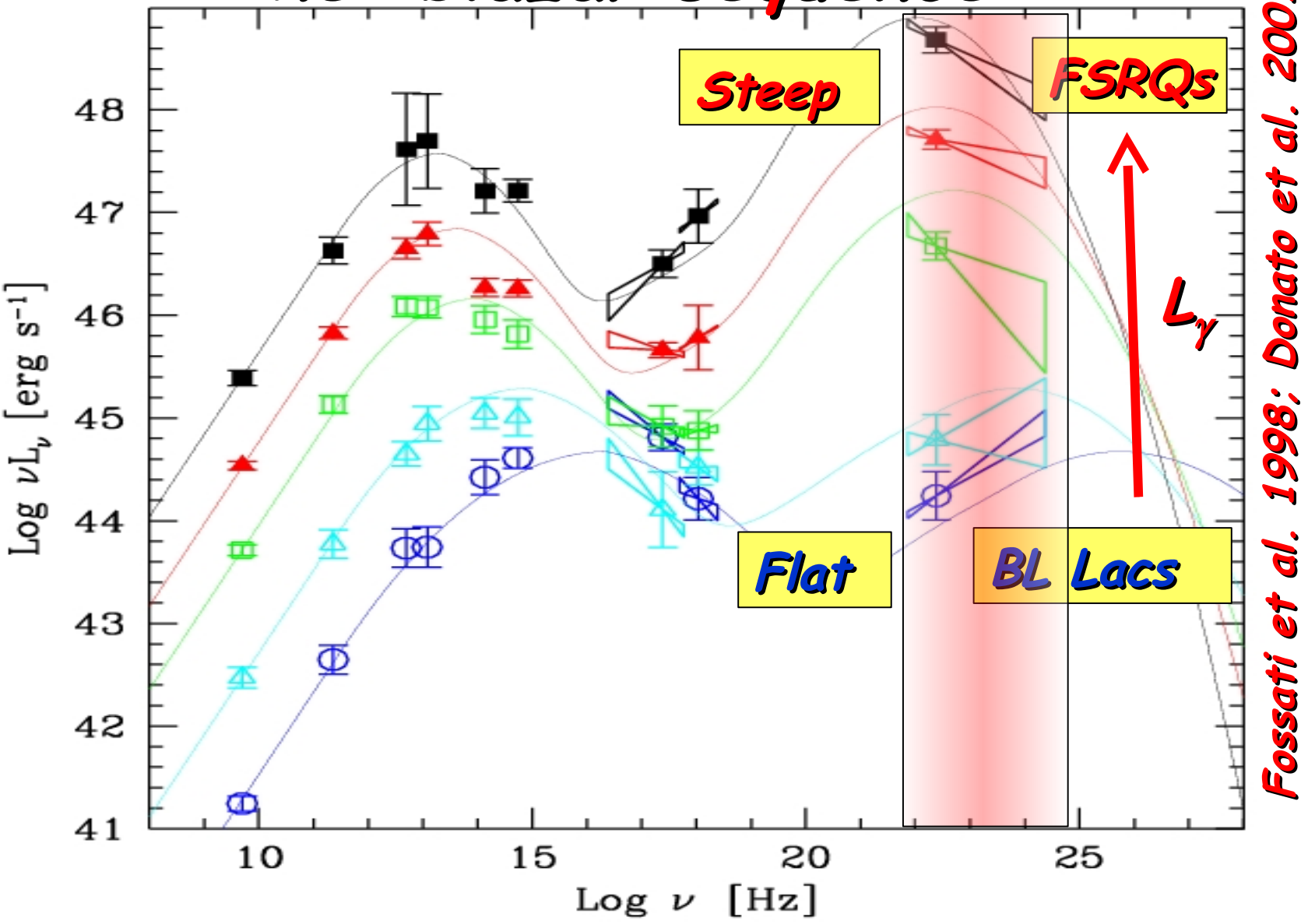

TeV
no GeV
0229+200
z=0.1396
NHXM
10⁴ s
Galaxy
$F_\nu \propto \nu^{1/3}$
Fermi U.L.
HESS
$F_\nu \propto \nu^{1/3}$
Log νF_ν [erg cm^{-2} s^{-1}]
Log νL_ν [erg s^{-1}]
Log ν [Hz]
−11
−12
−13
−14
45
44
43
42
10
15
20
25
Tavecchio+ 2009


TeV
no GeV
0229+200
z=0.1396
NHXM
10⁴ s
Fermi U.L.
Galaxy
$F_\nu \propto \nu^{1/3}$
$F_\nu \propto \nu^{1}$
Strong impact on EBL
Log νF_ν [erg cm^{-2} s^{-1}]
Log νL_ν [erg s^{-1}]
Log ν [Hz]
−11
−12
−13
−14
45
44
43
42
15
20
25
Tavecchio+ 2009


TeV
no GeV
0229+200
z=0.1396
NHXM
10⁴ s
Fermi U.L.
Galaxy
Log νF_ν [erg cm⁻² s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]
Attention to polarization...
Optical dominated by host
Tavecchio+ 2009

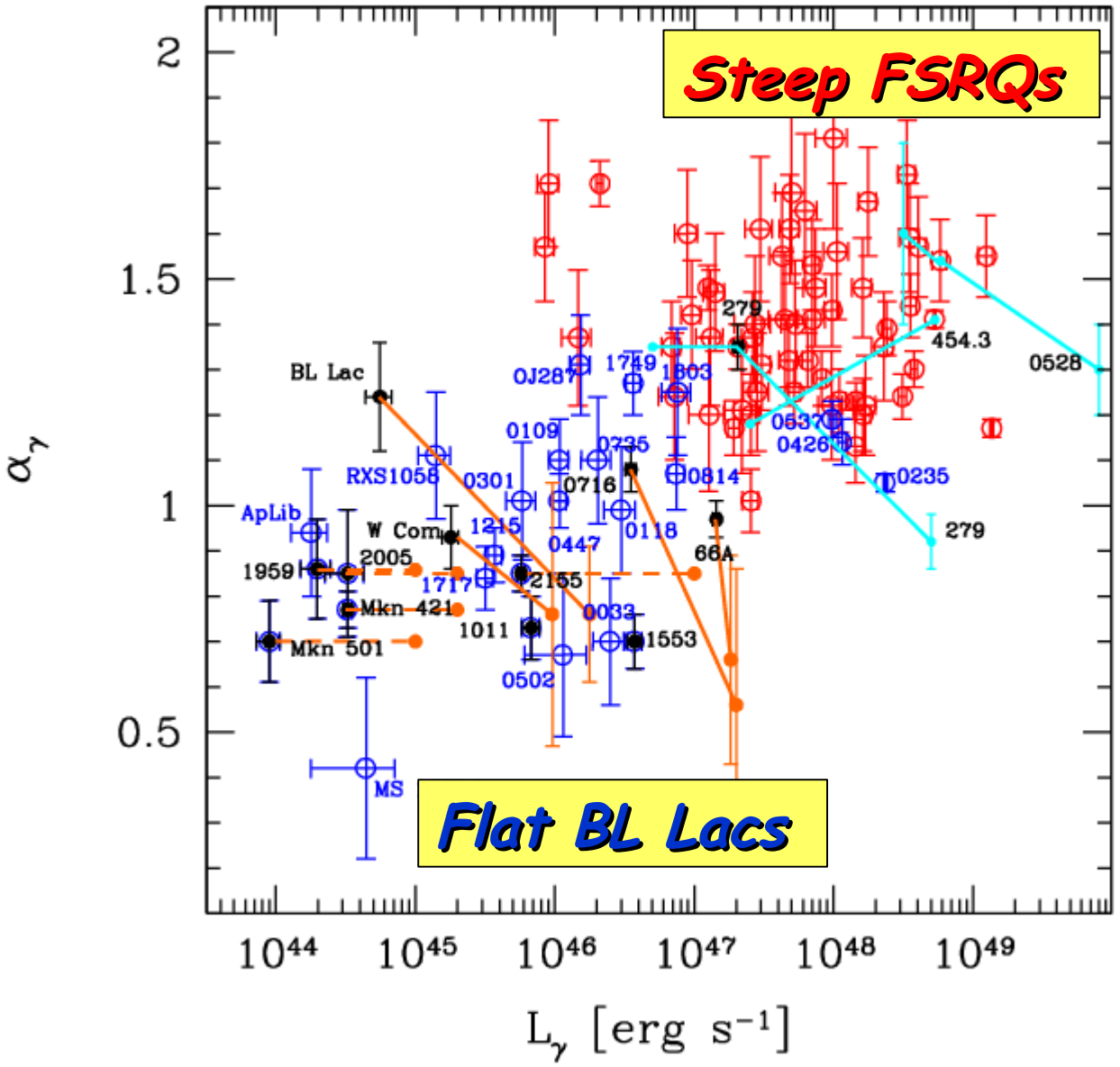
Fermi & BAT blazars

The "blazar sequence"

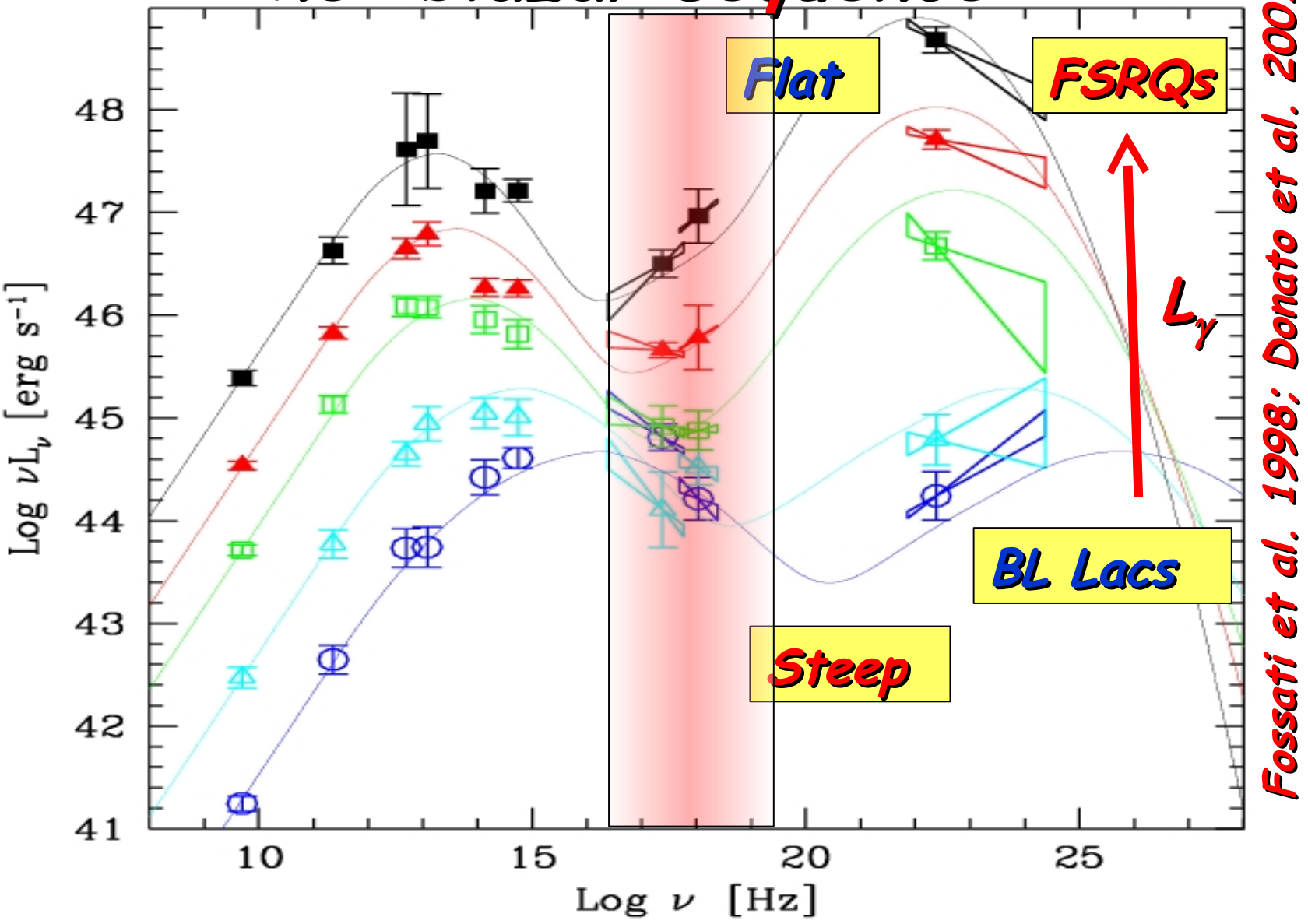


Fossati et al. 1998; Donato et al. 2001

The Fermi sequence

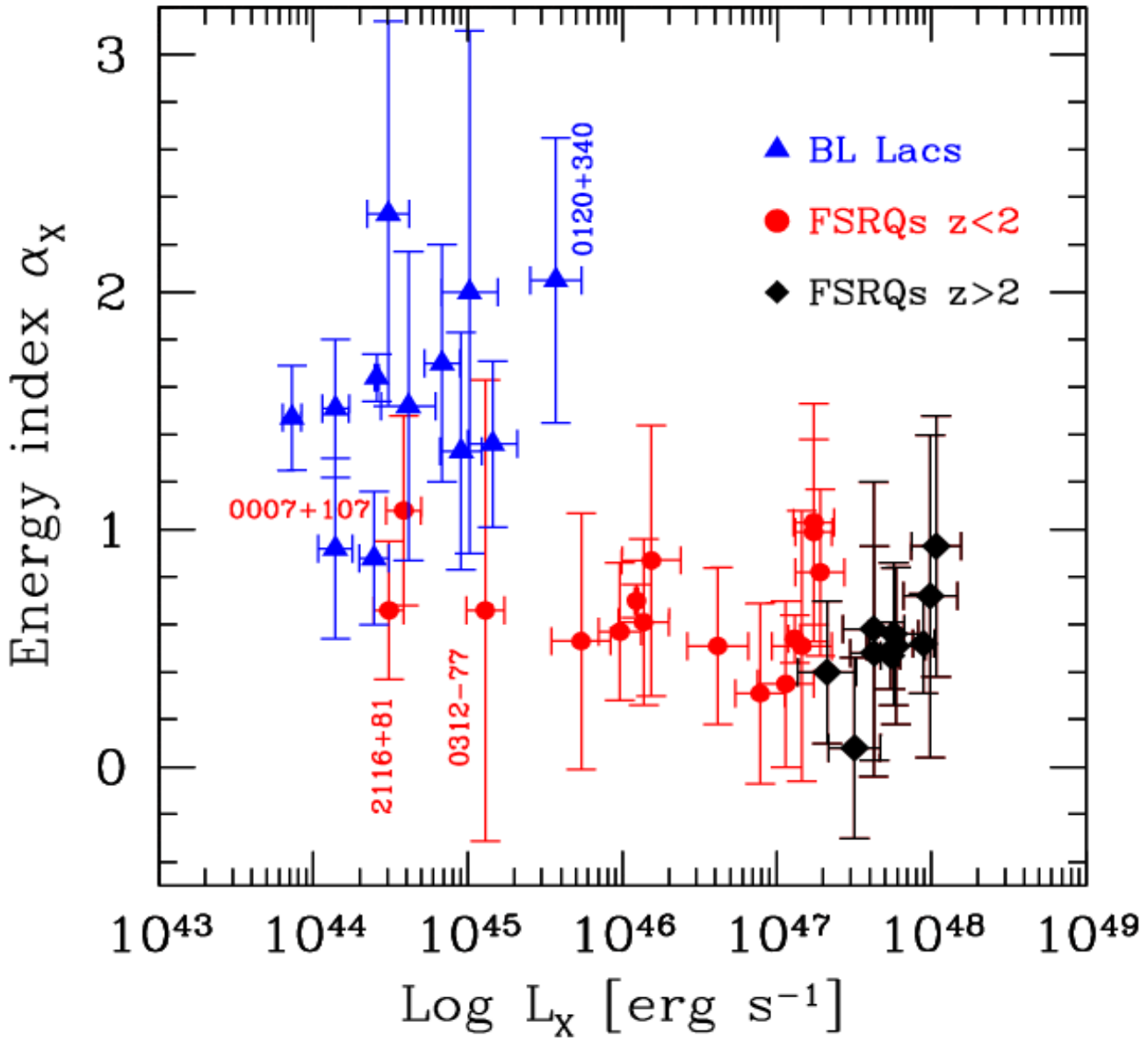


The "blazar sequence"

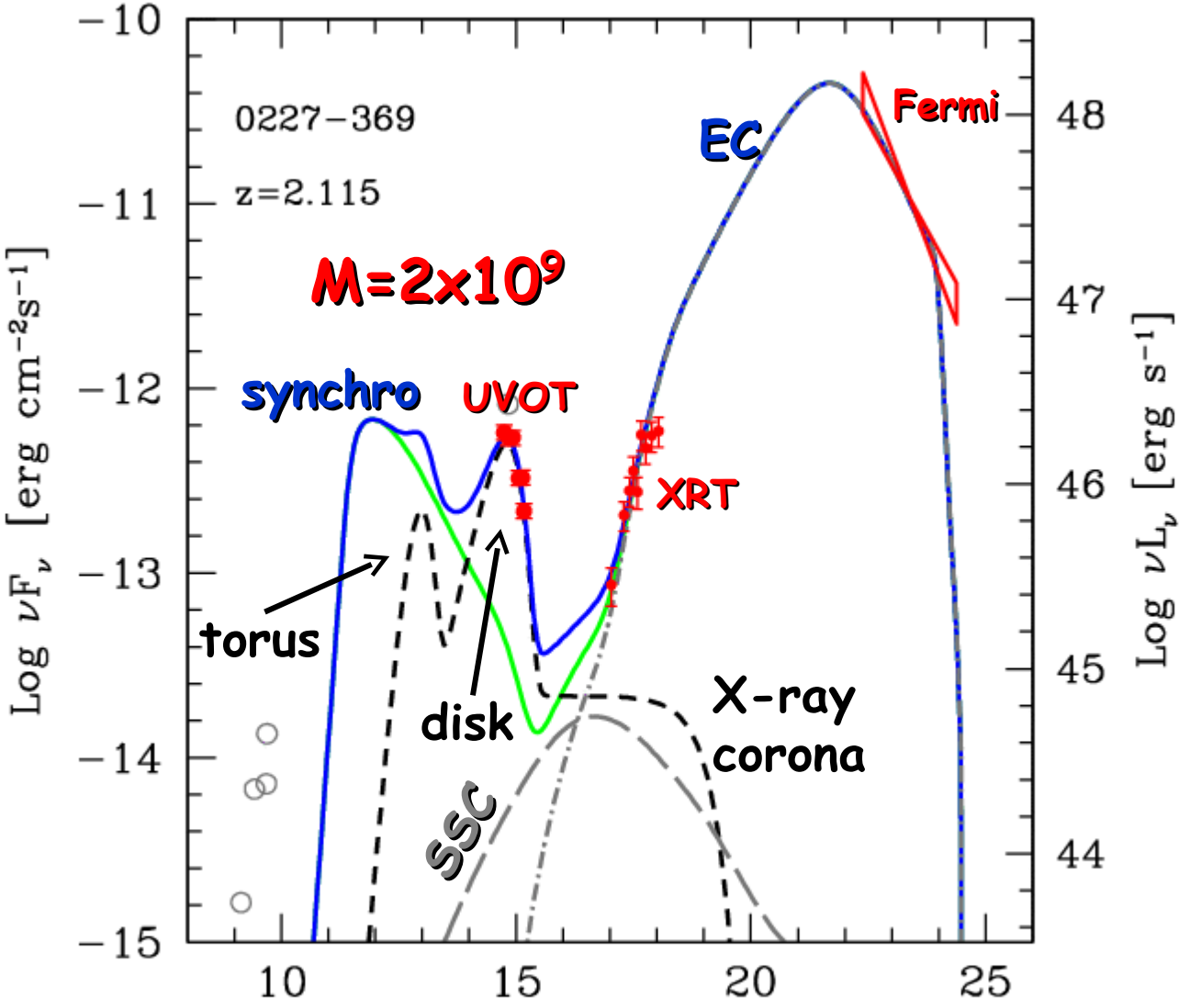


Fossati et al. 1998; Donato et al. 2001

The BAT sequence

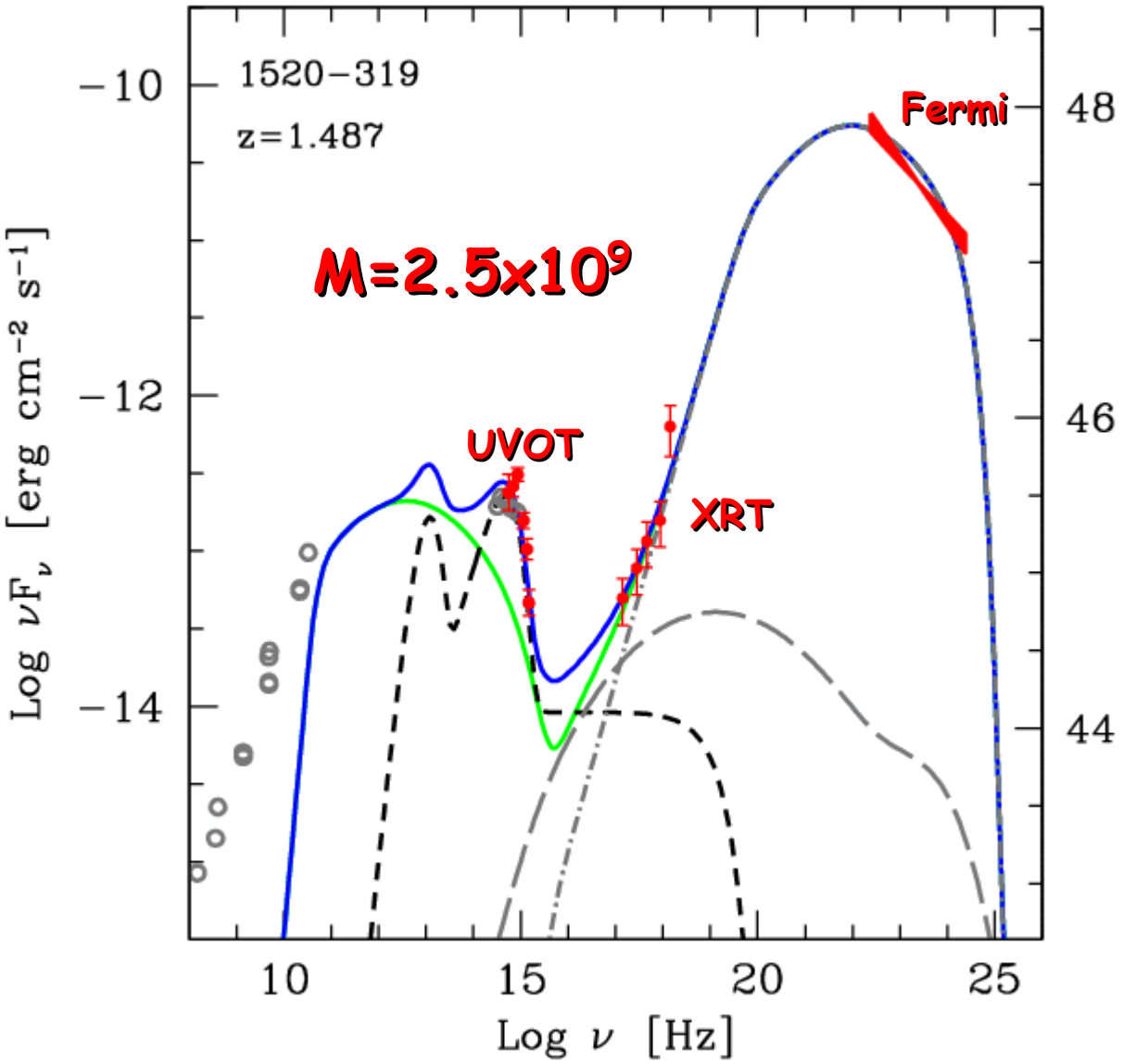


Fermi big blazars: powerful, with emission lines and radio lobes



Low energy synchro peak:
leave the disk naked!

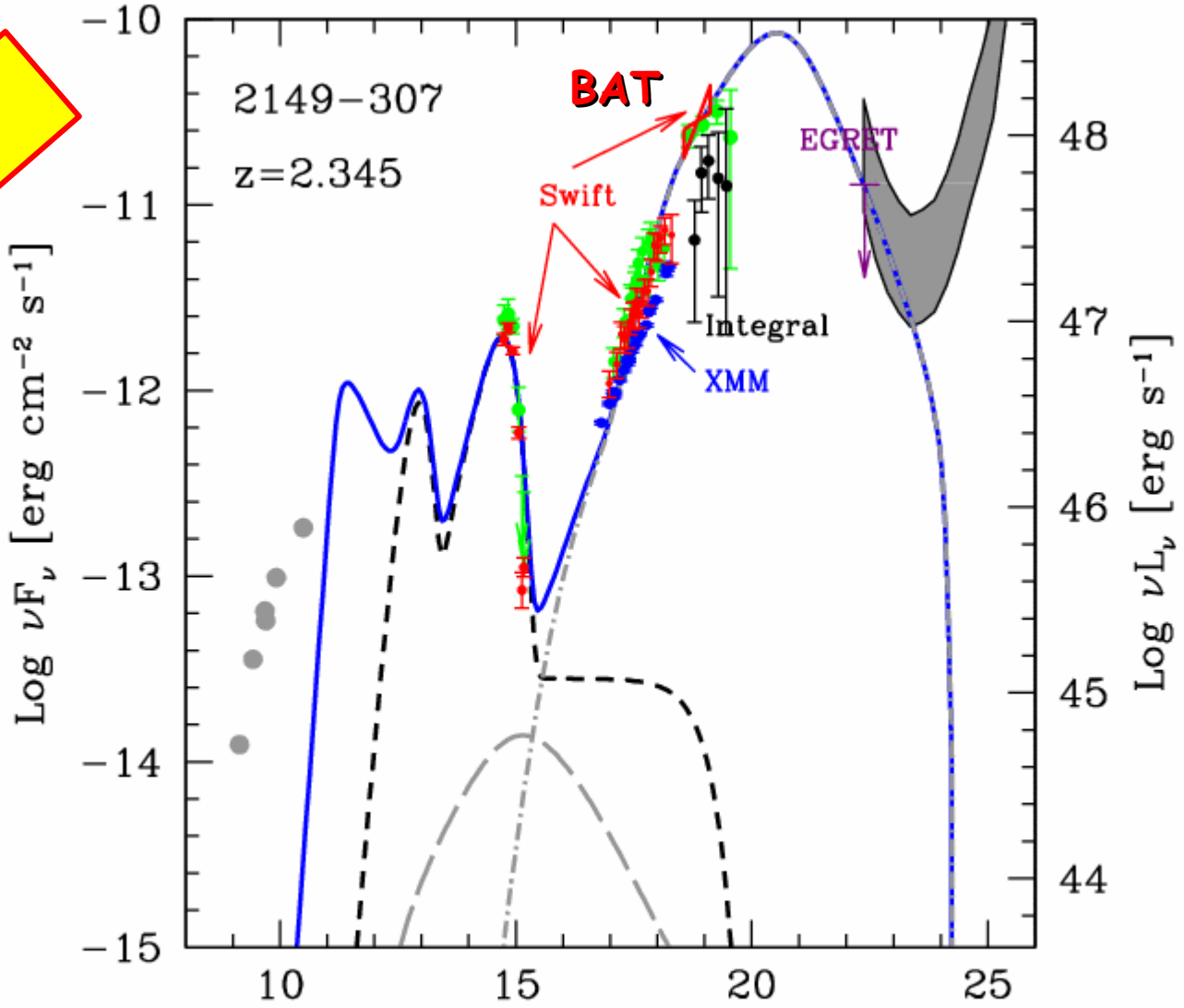
GG, Tavecchio & Ghirlanda 2009



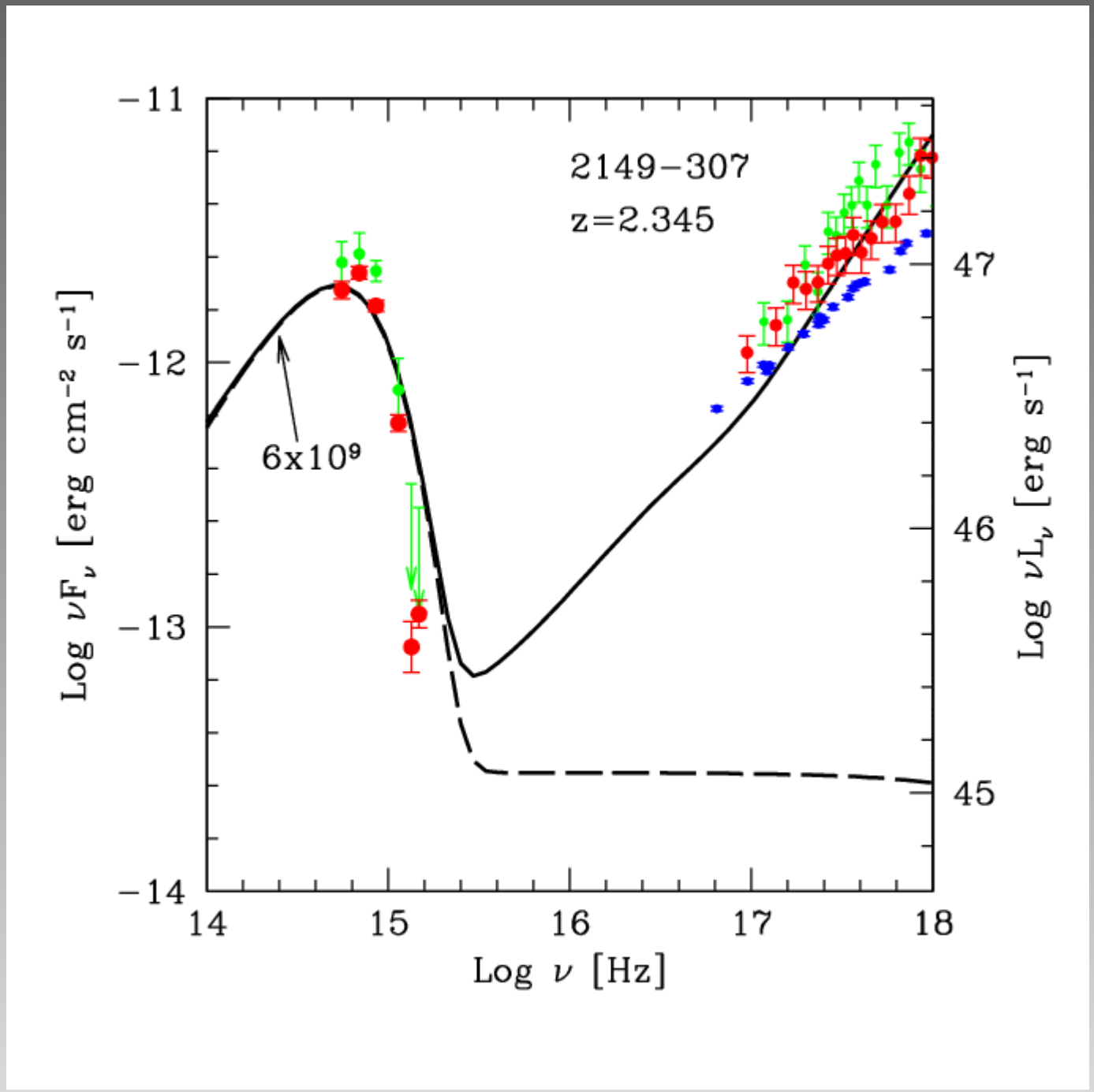
GG, Tavecchio & Ghirlanda 2009

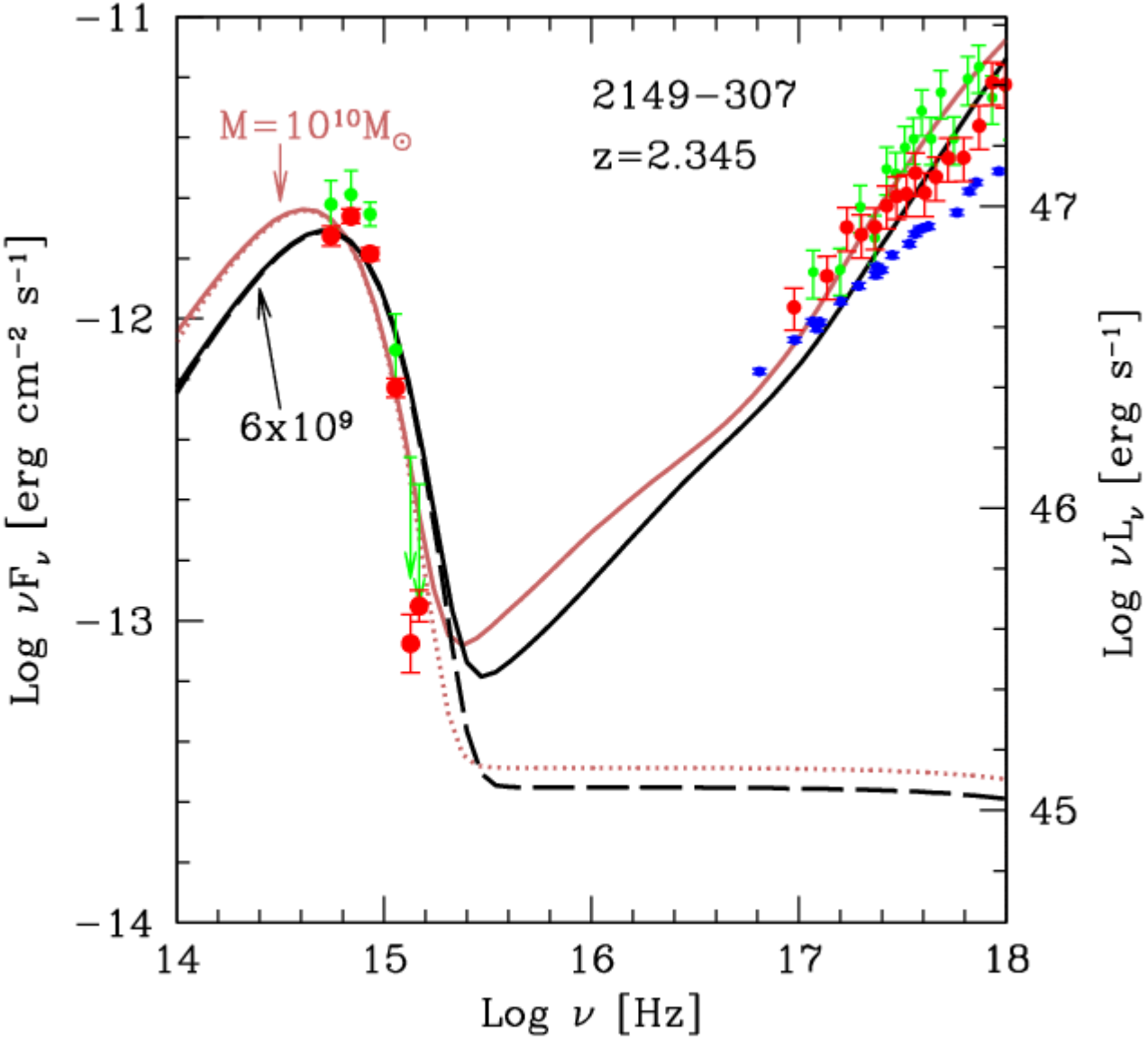
BAT even bigger blazars

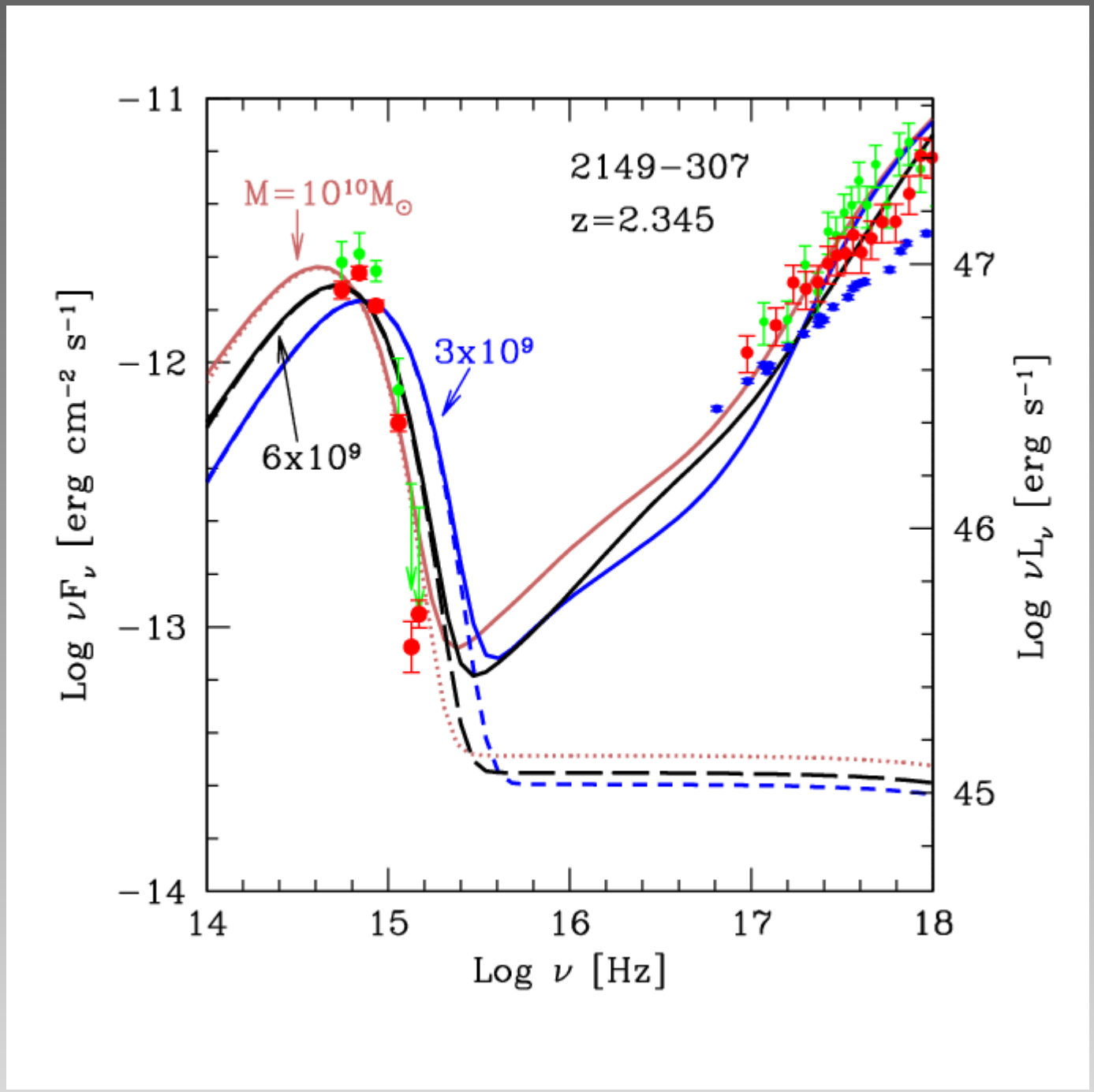
$M_{BH}=6x10^9$

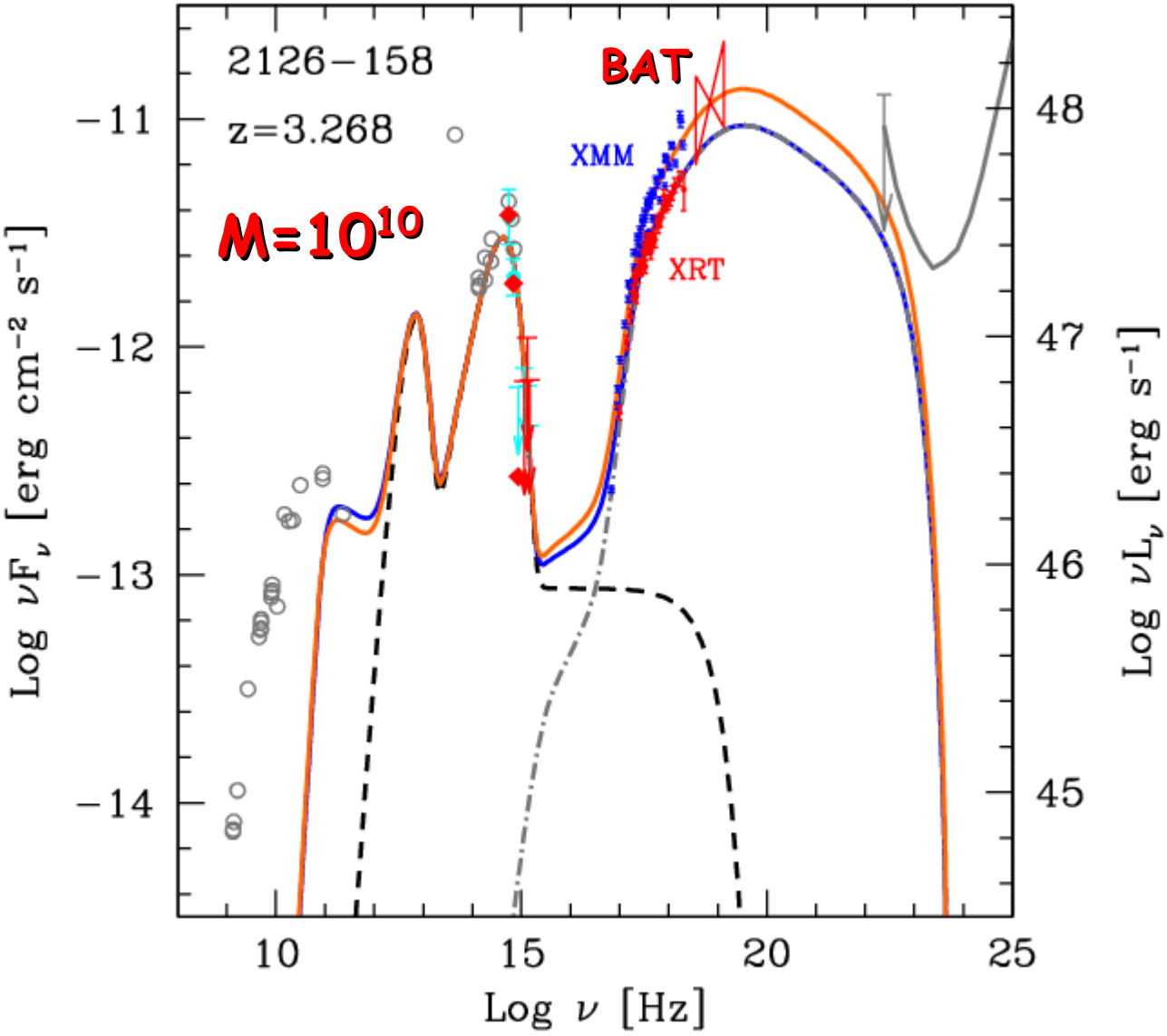


GG+ almost ready

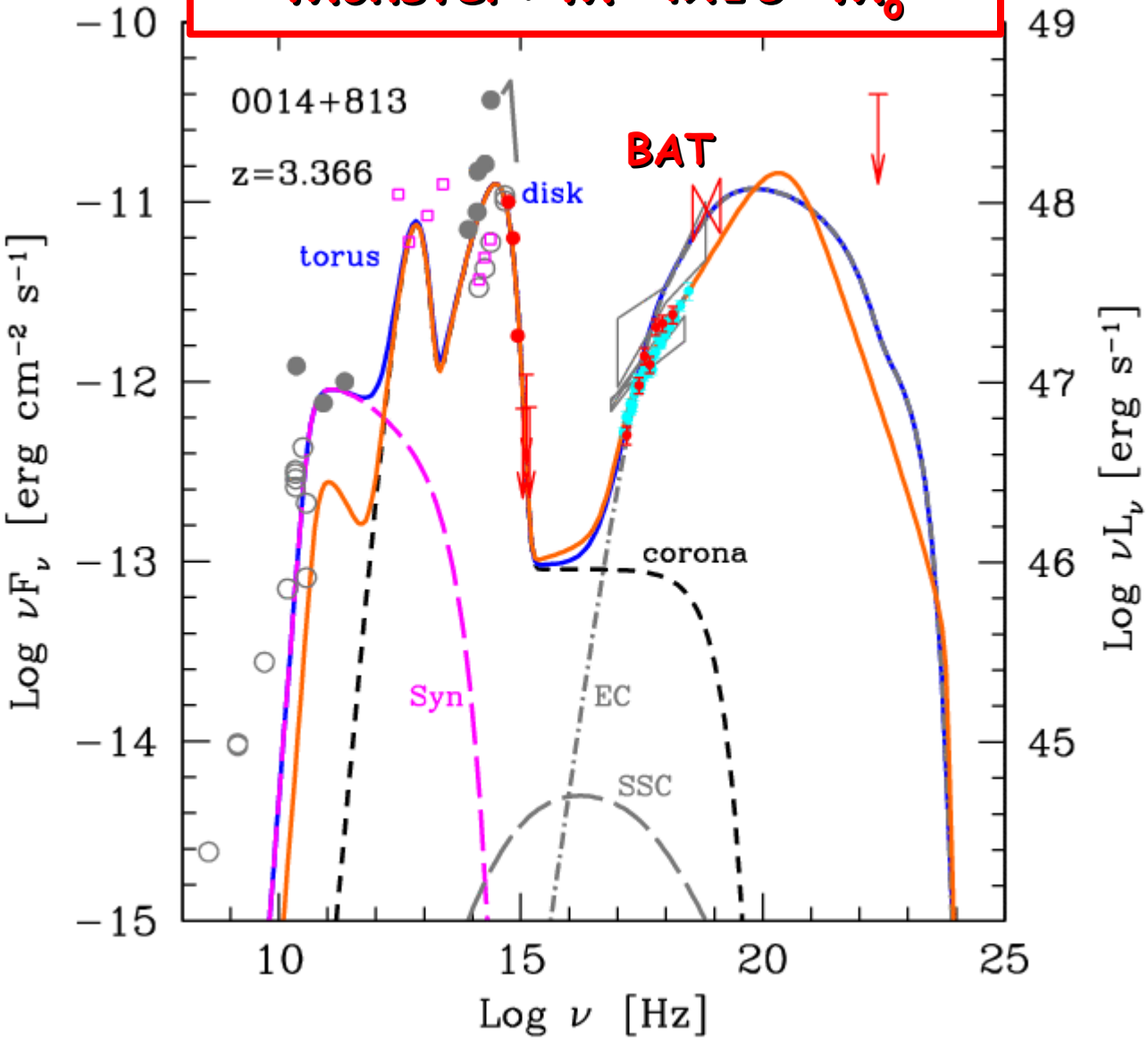

2149−307
z=2.345
6x10⁹
Log νF_ν [erg cm⁻² s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]
−11
−12
−13
−14
14
15
16
17
18
47
46
45

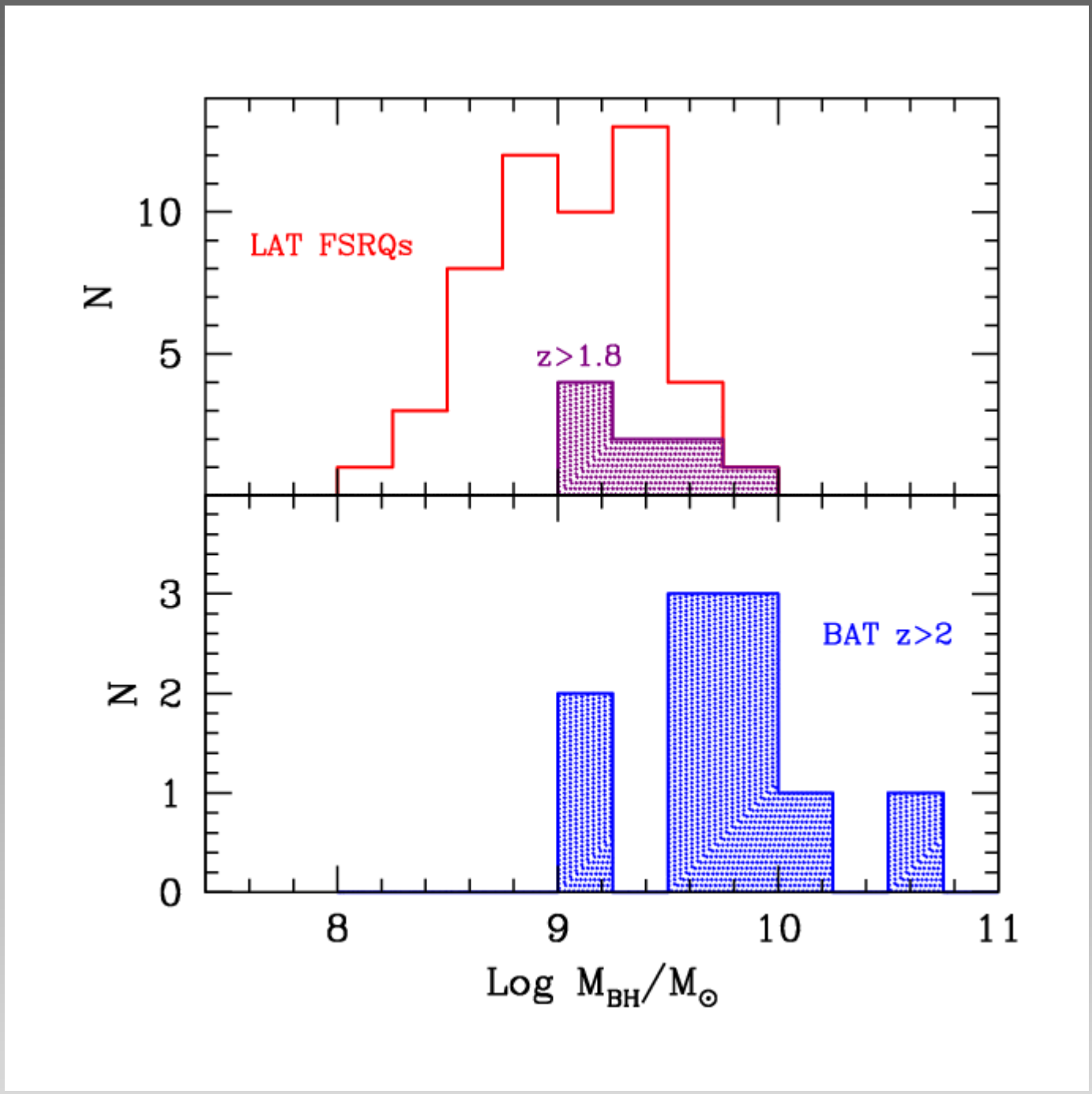

2149−307
z=2.345
M=10¹⁰M⊙
6x10⁹
Log νF_ν [erg cm⁻² s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]
−11
−12
−13
−14
14
15
16
17
18
47
46
45


2149−307
z=2.345
M=10¹⁰M⊙
3x10⁹
6x10⁹
Log νF_ν [erg cm⁻² s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]
−11
−12
−13
−14
14
15
16
17
18
47
46
45


2126−158
z=3.268
M=10^10
BAT
XMM
XRT
−11
−12
−13
−14
48
47
46
45
10
15
20
25
Log νF_ν [erg cm^−2 s^−1]
Log νL_ν [erg s^−1]
Log ν [Hz]

Monster: $M=4\times10^{10}M_{\odot}$




LAT FSRQs
z>1.8
BAT z>2
N
10
5
3
2
1
0
8
9
10
11
Log $M_{BH}/M_{\odot}$

jet power and accretion luminosity

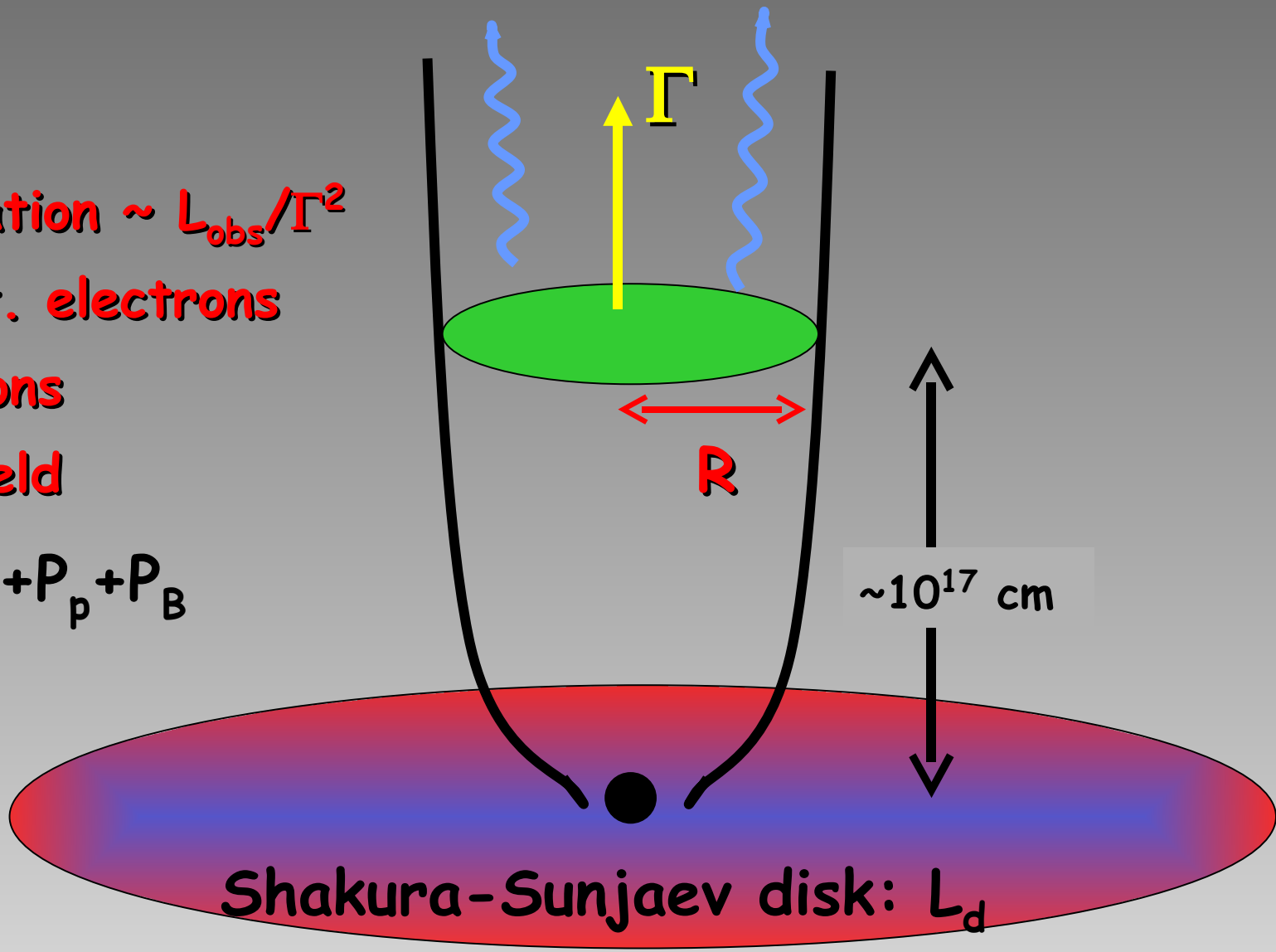
P_r = radiation ~ L_{obs}/Γ^2

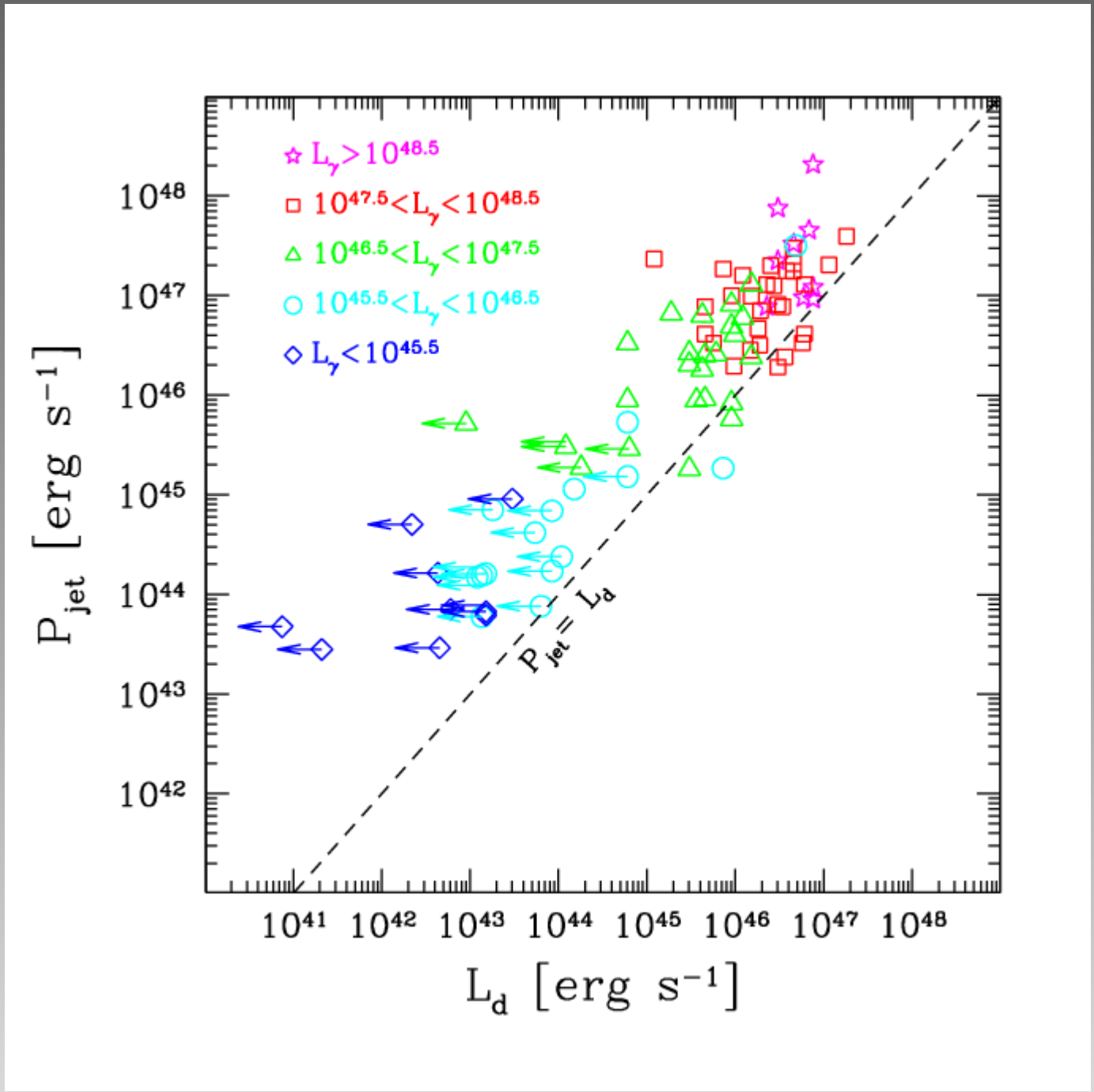
P_e = relat. electrons

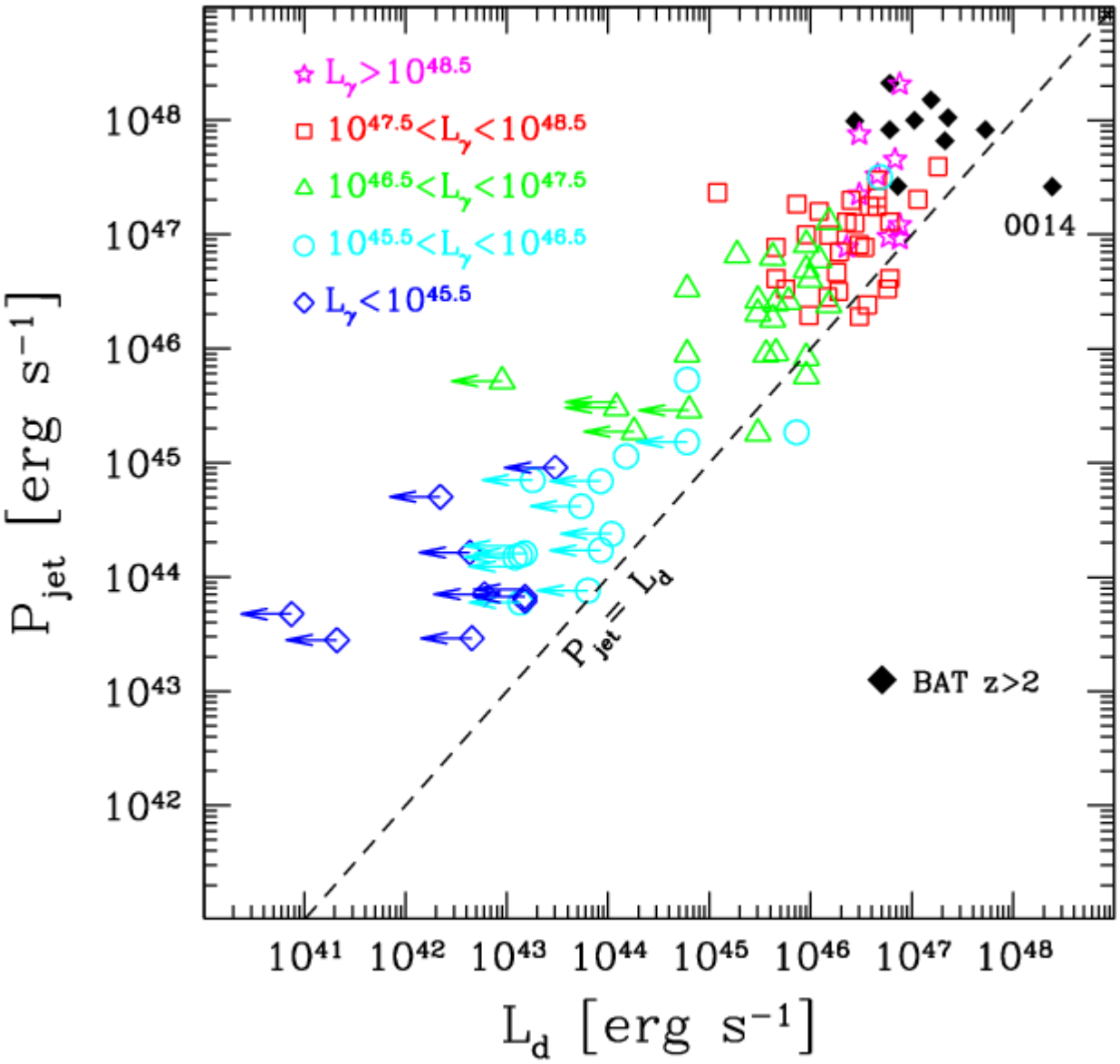
P_p = protons

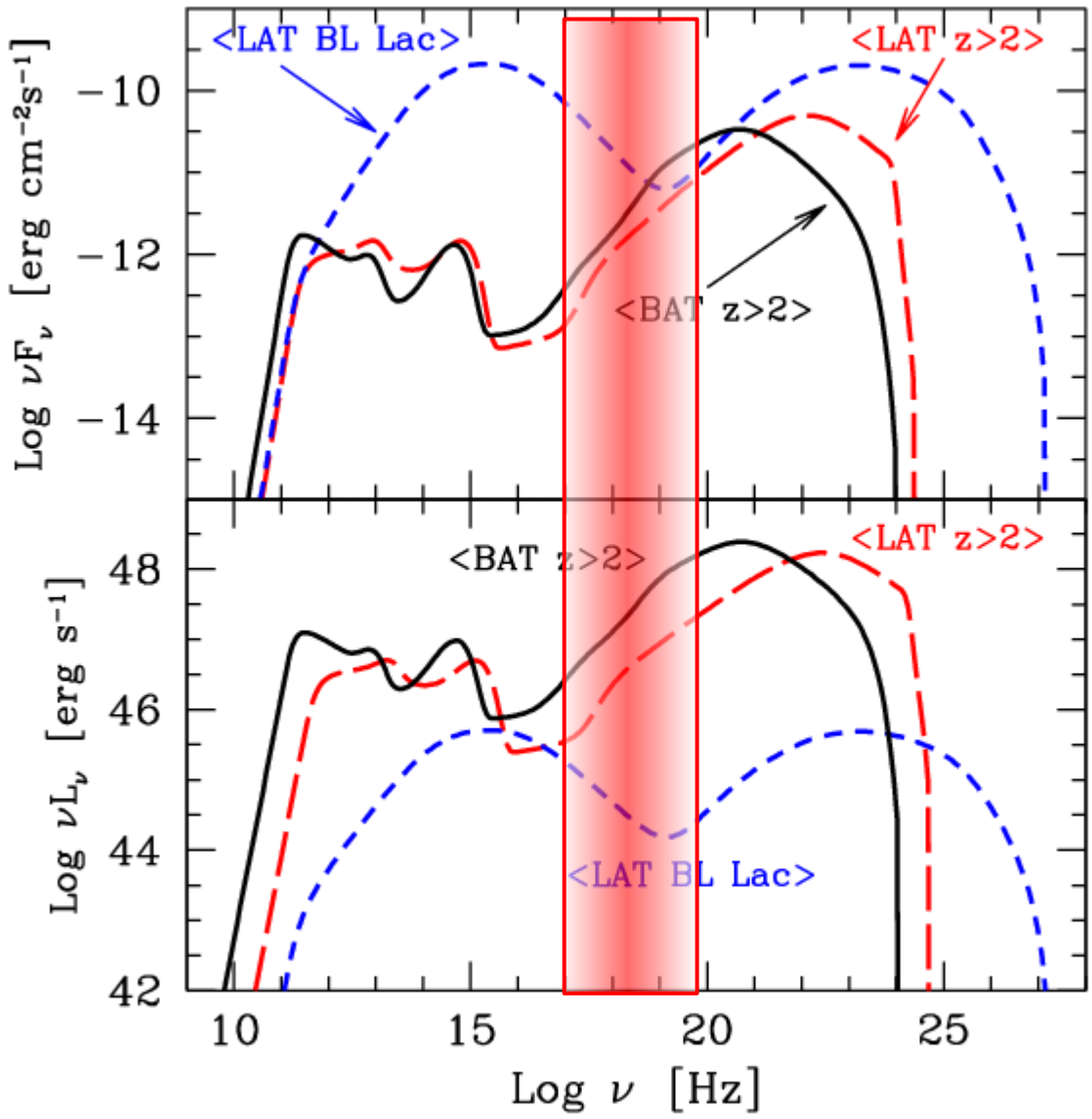
P_B = B-field

$P_{jet} = P_e + P_p + P_B$



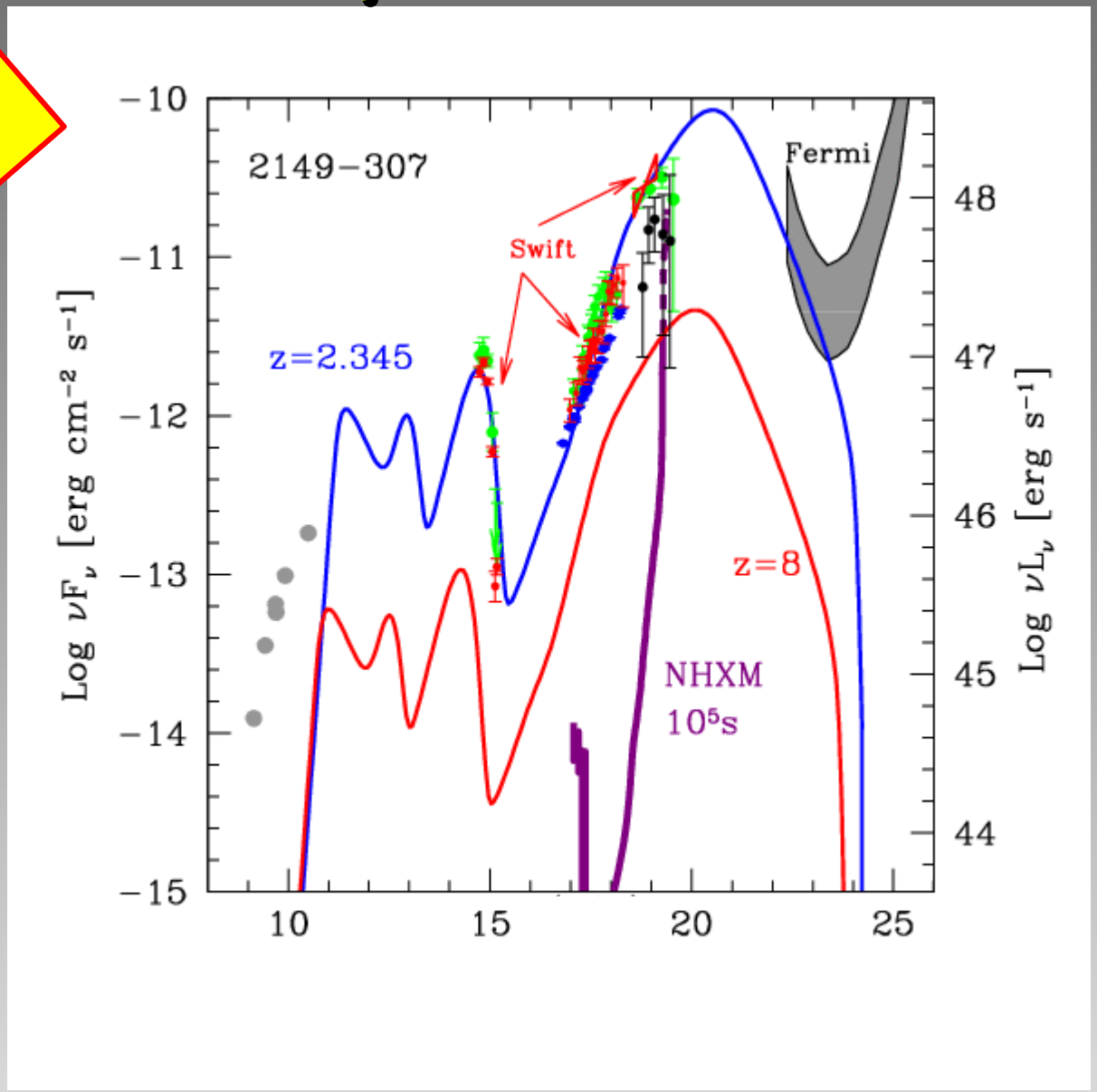

$L_\gamma > 10^{48.5}$
$10^{47.5} < L_\gamma < 10^{48.5}$
$10^{46.5} < L_\gamma < 10^{47.5}$
$10^{45.5} < L_\gamma < 10^{46.5}$
$L_\gamma < 10^{45.5}$
$P_{jet} = L_d$
P_{jet} [erg s^{-1}]
L_d [erg s^{-1}]
10^{41} 10^{42} 10^{43} 10^{44} 10^{45} 10^{46} 10^{47} 10^{48}
10^{42} 10^{43} 10^{44} 10^{45} 10^{46} 10^{47} 10^{48}


$L_\gamma > 10^{48.5}$
$10^{47.5} < L_\gamma < 10^{48.5}$
$10^{46.5} < L_\gamma < 10^{47.5}$
$10^{45.5} < L_\gamma < 10^{46.5}$
$L_\gamma < 10^{45.5}$
0014
BAT z>2
$P_{jet} = L_d$
P_{jet} [erg s^{-1}]
L_d [erg s^{-1}]
10^{41} 10^{42} 10^{43} 10^{44} 10^{45} 10^{46} 10^{47} 10^{48}
10^{42} 10^{43} 10^{44} 10^{45} 10^{46} 10^{47} 10^{48}


<LAT BL Lac>
<LAT z>2>
<BAT z>2>
Log νF_ν [erg cm^-2 s^-1]
−10
−12
−14
<BAT z>2>
<LAT z>2>
<LAT BL Lac>
Log νL_ν [erg s^-1]
48
46
44
42
10
15
20
25
Log ν [Hz]

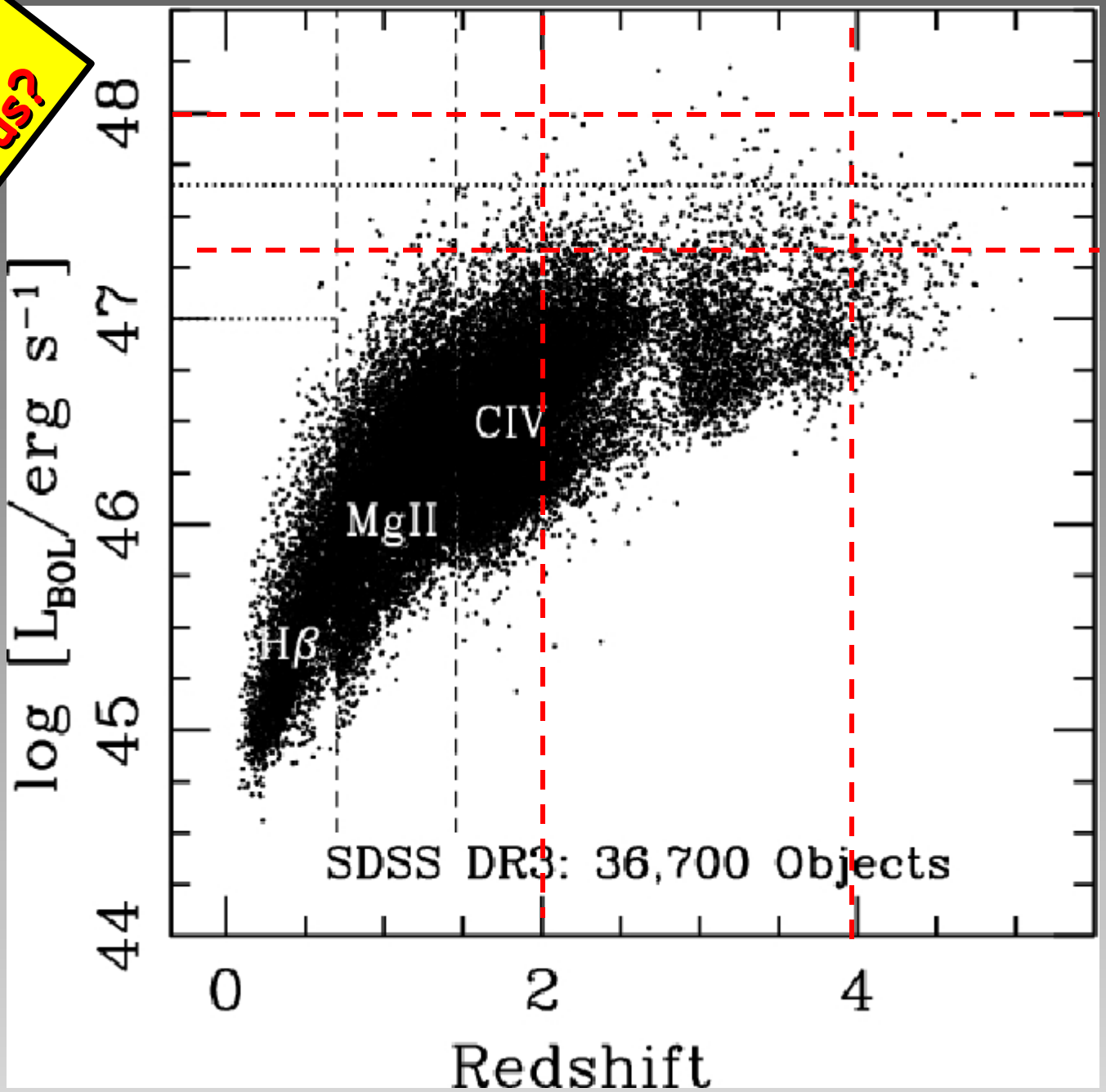
Up to z=8!

$M_{BH}=6x10^9$



$$1 = 2\Gamma^2$$

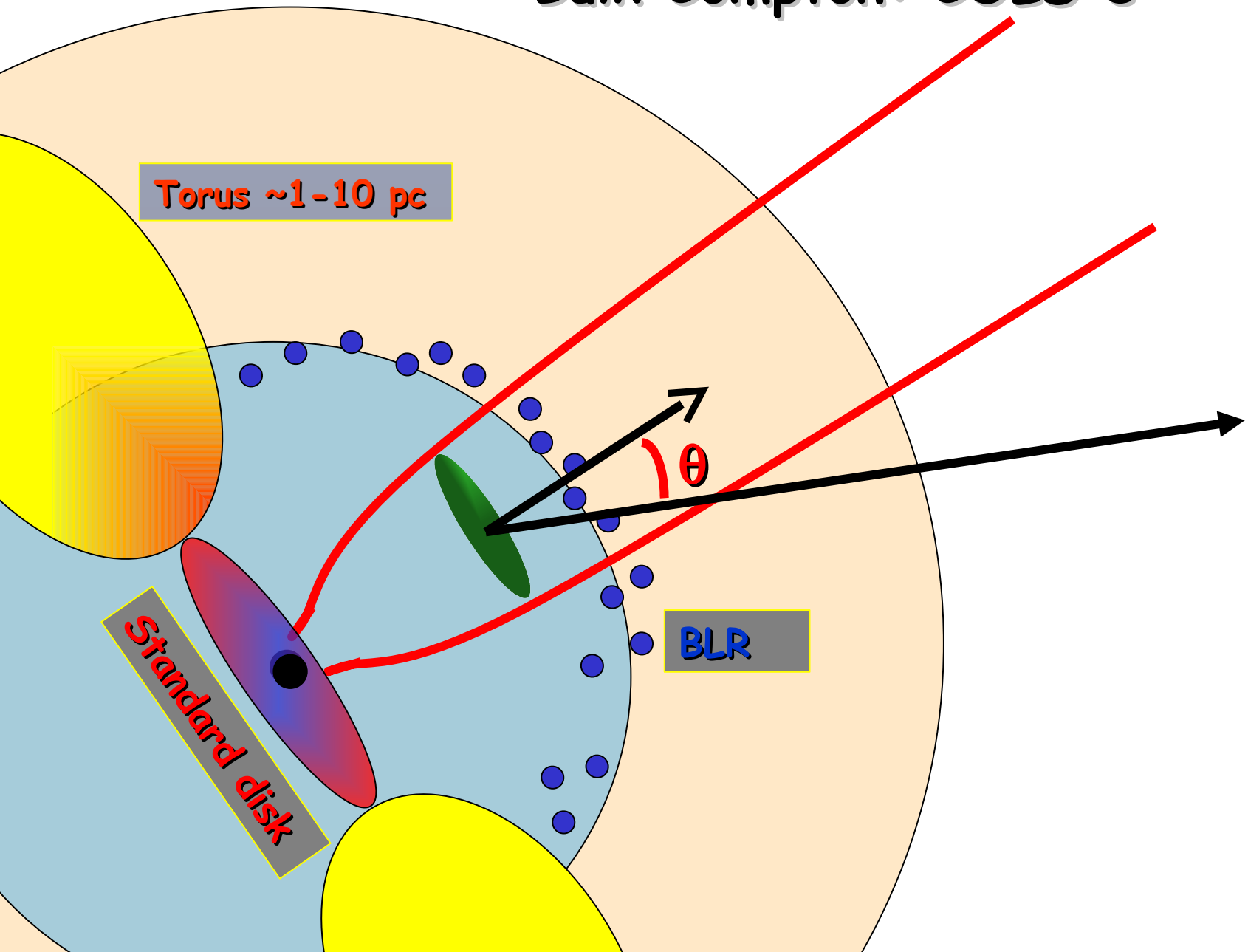
In Optical, but what if there is the torus?



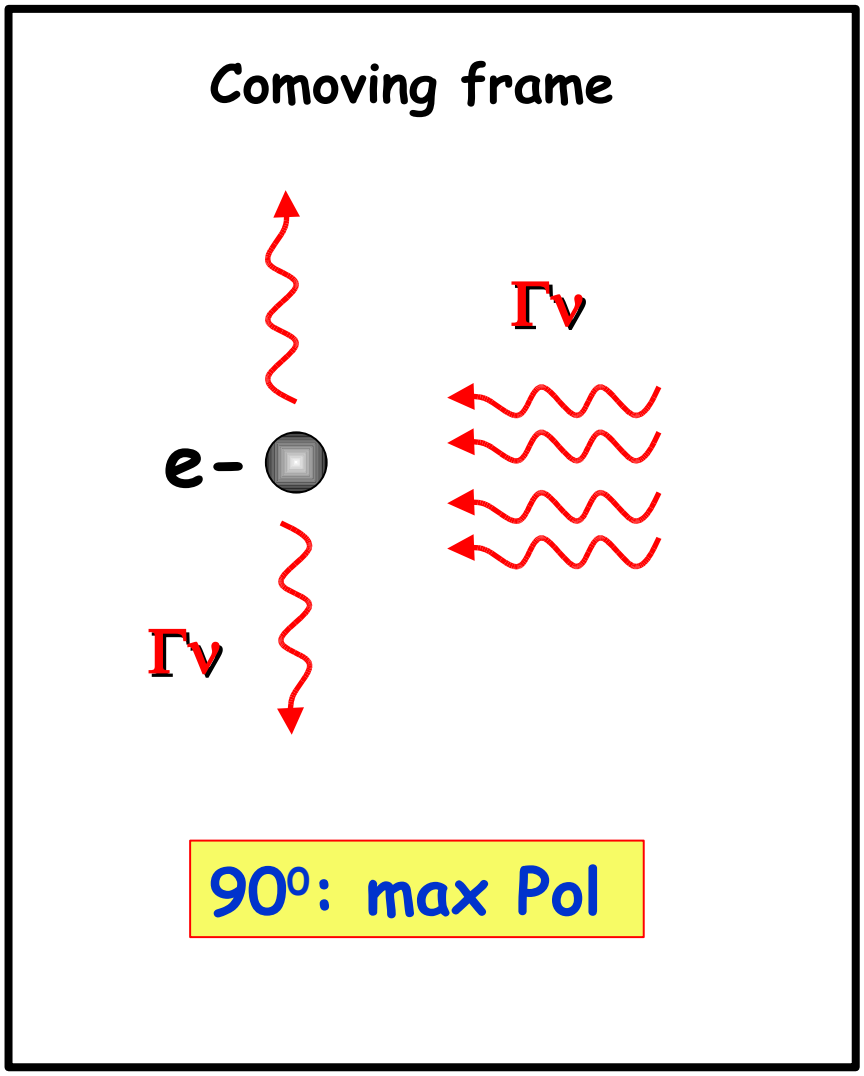
Vestergaard 0904.2615

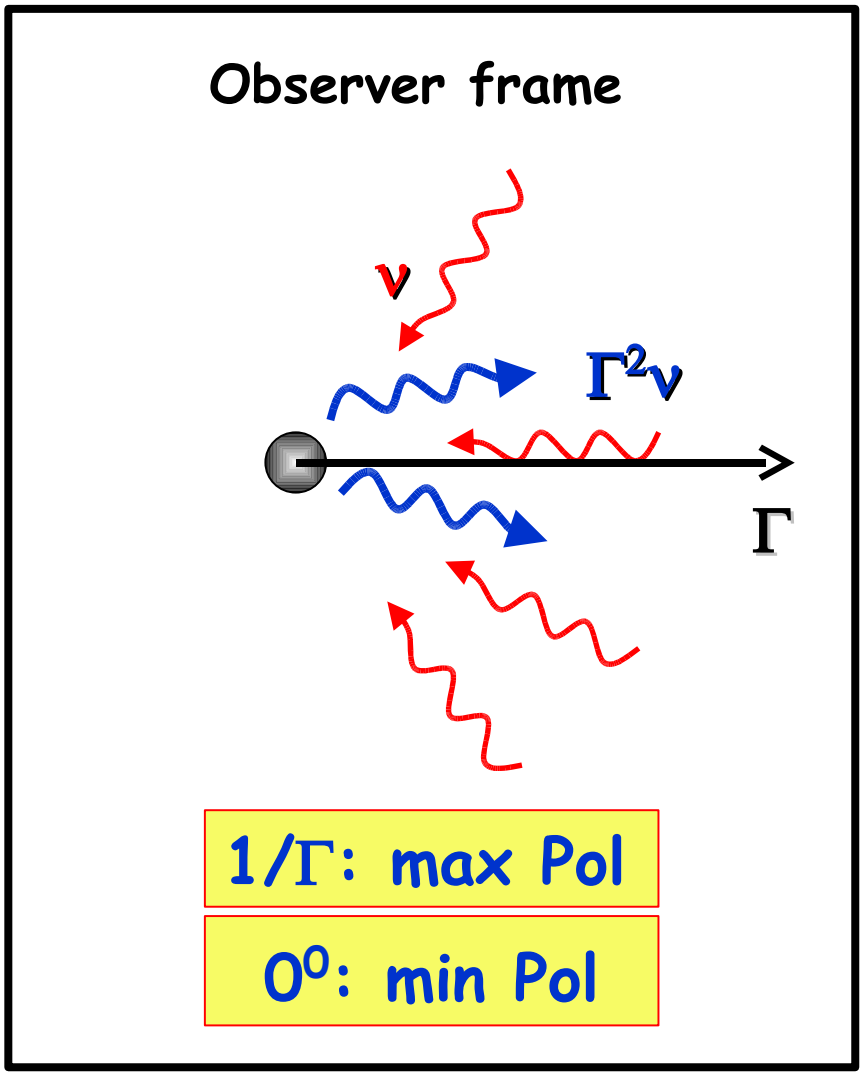
Polarization

Bulk Compton: COLD e-



Bulk Compton: COLD e-

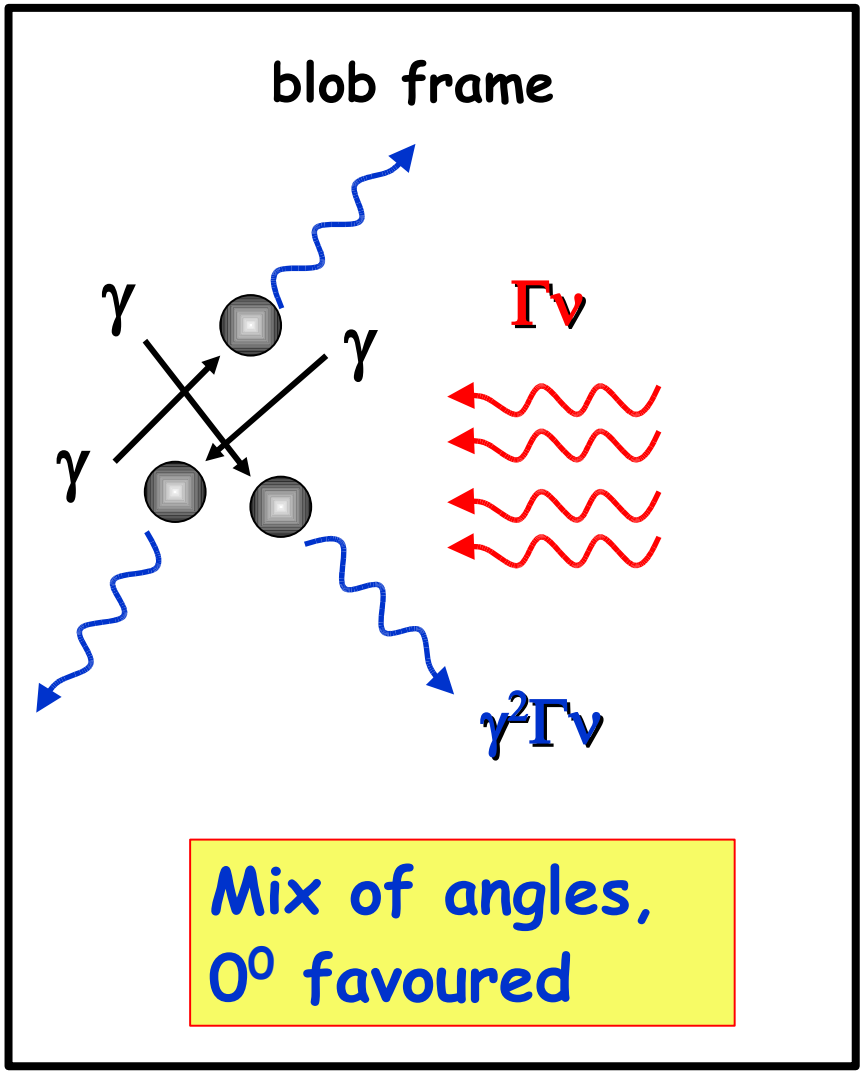


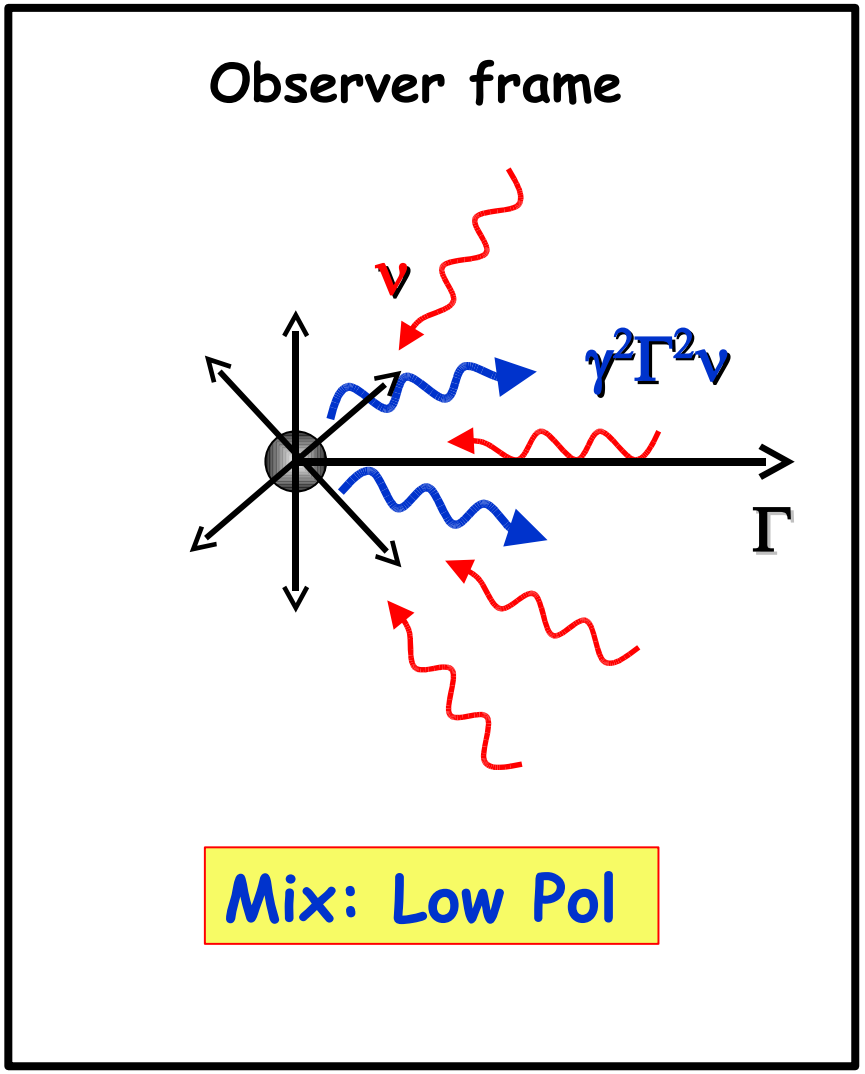


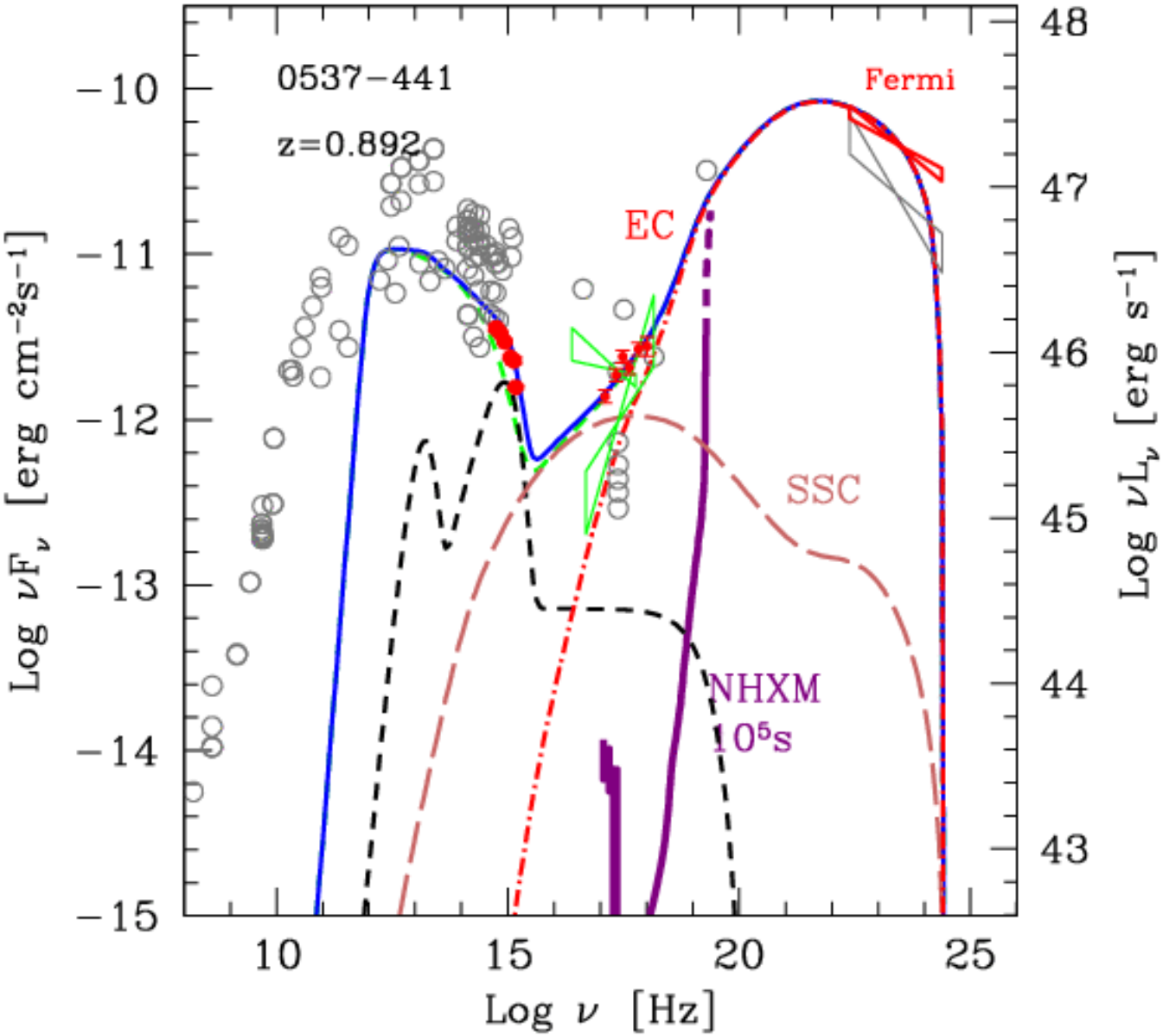
SSC

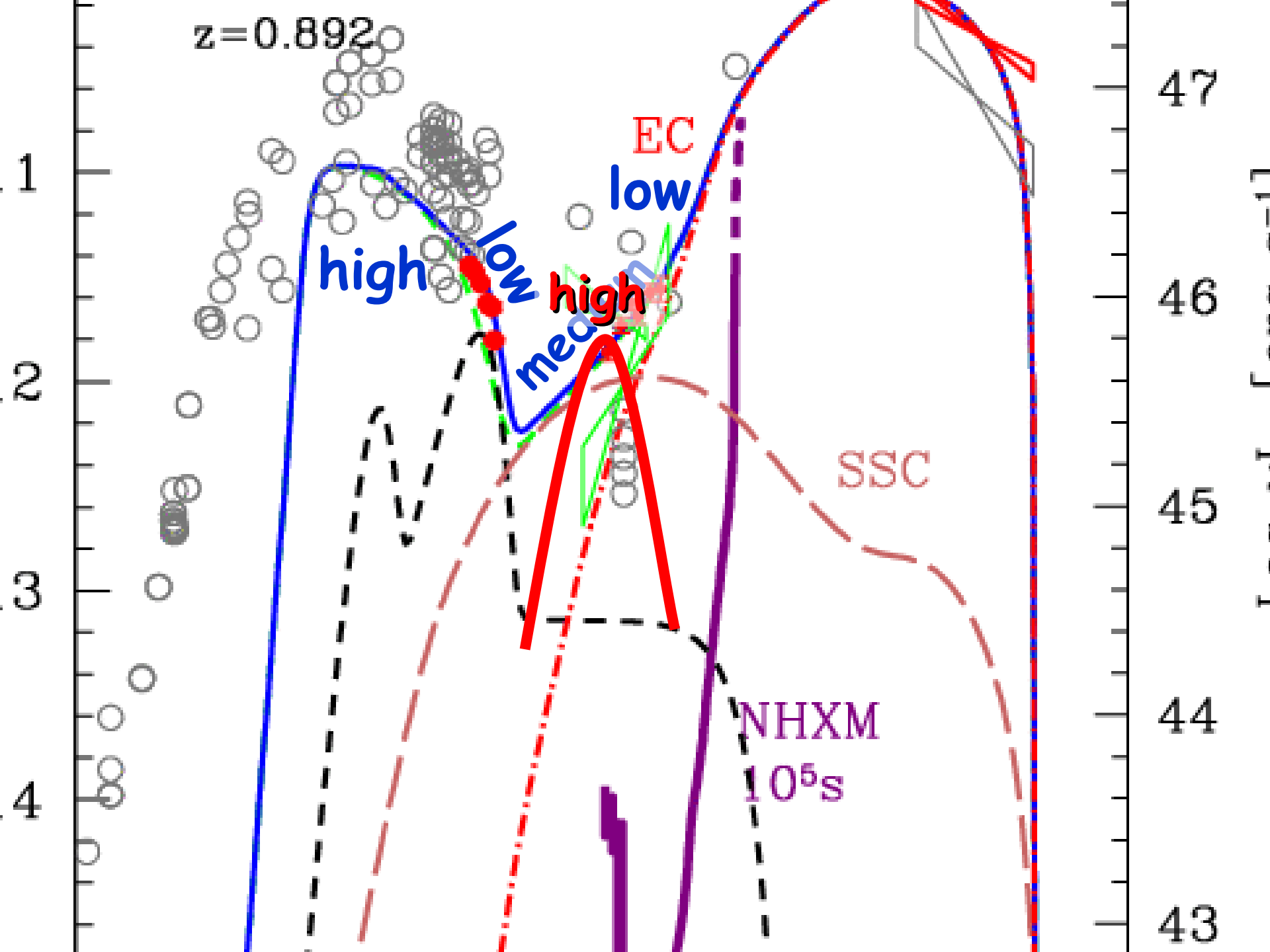
- Synchro already polarized
- With the Compton mix of angles: SSC still polarized, but less

External Compton: relativistic e-



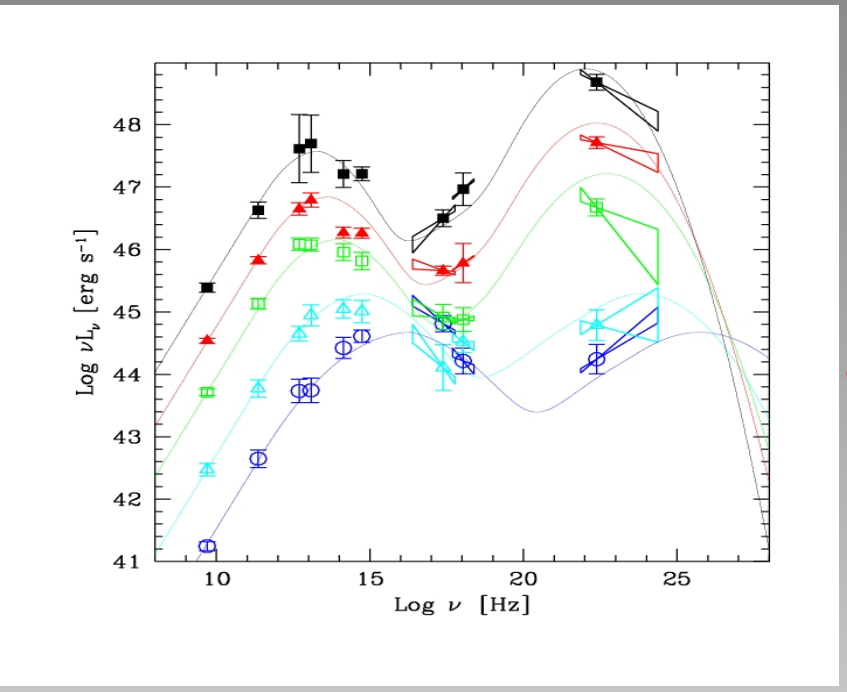



0537−441
z=0.892
Fermi
EC
SSC
NHXM
10⁵s
Log νF_ν [erg cm⁻²s⁻¹]
Log νL_ν [erg s⁻¹]
Log ν [Hz]
−10
−11
−12
−13
−14
−15
48
47
46
45
44
43
10
15
20
25


z=0.892
EC
low
high
low
high
medium
SSC
NHXM
10^5s
47
46
45
44
43
1
2
3
4

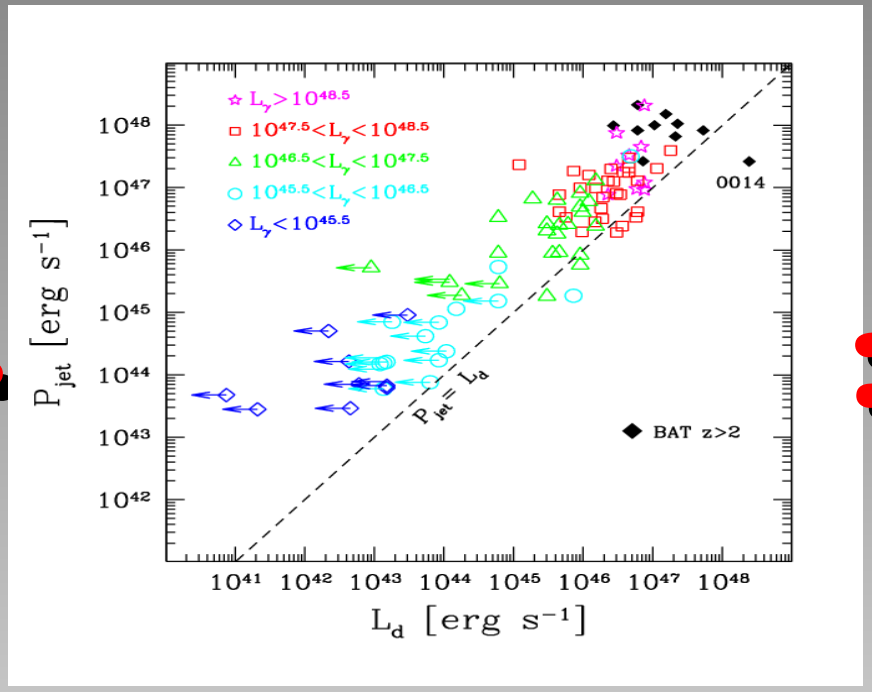
Conclusion 1: the message

Blazar sequence



+

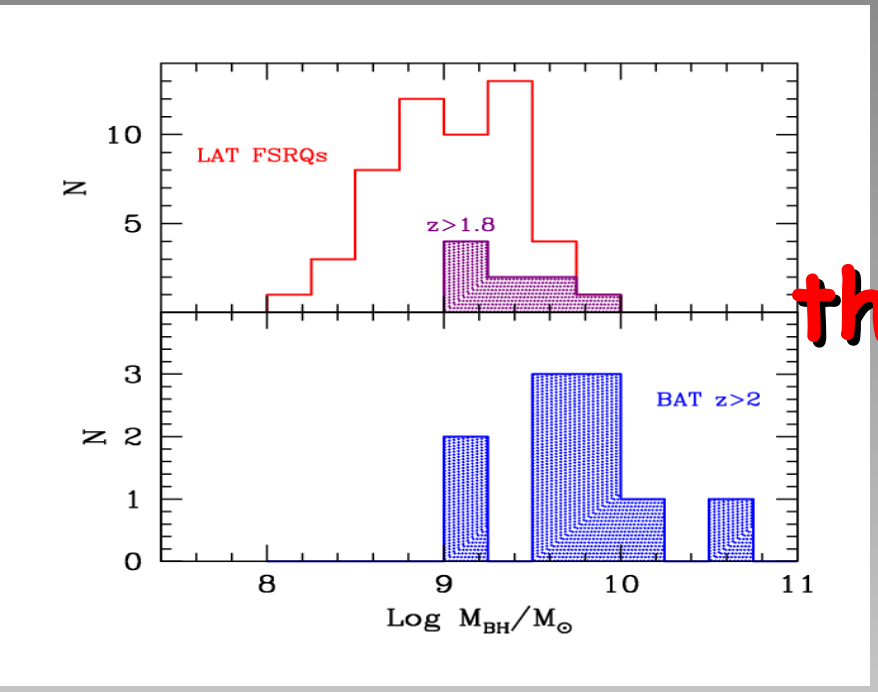
Disk/jet connection



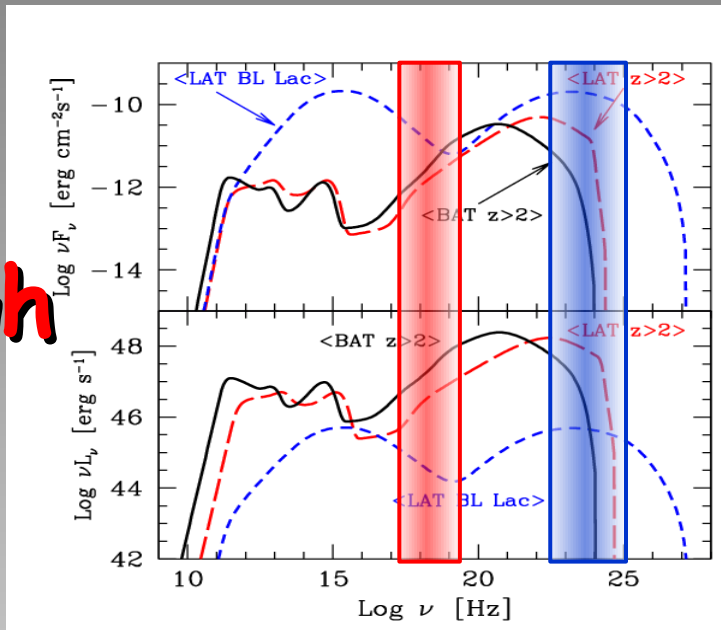
=

Heaviest BHs

Hard X-rays



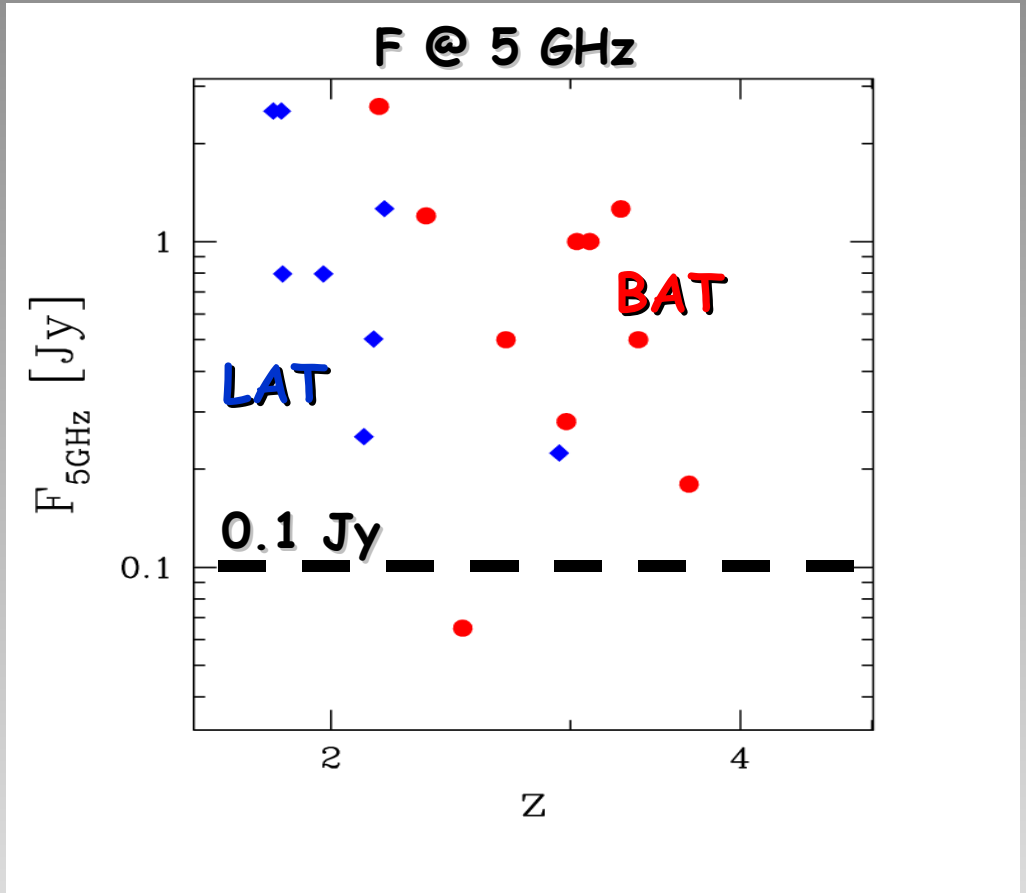
through



Discovery space:

Select:

- Radio sources F(5 GHz)>0.1 Jy
- hard in 2-10 keV ($\alpha_x \lesssim 0.5$)
- Large z



Conclusions

- Hard X-rays are not absorbed. SDSS may.
- Radio loud may require/produce bigger holes: if so, hard X-rays are The way.
- Polarization changes in X-rays can confirm/reject existing models.
- Trends may rule out internal shocks
- Strange TeV BL Lacs. No e- at low energies, no cooling, all action at $\gamma > 10^5$