

Multi-wavelength emission models in blazars

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with

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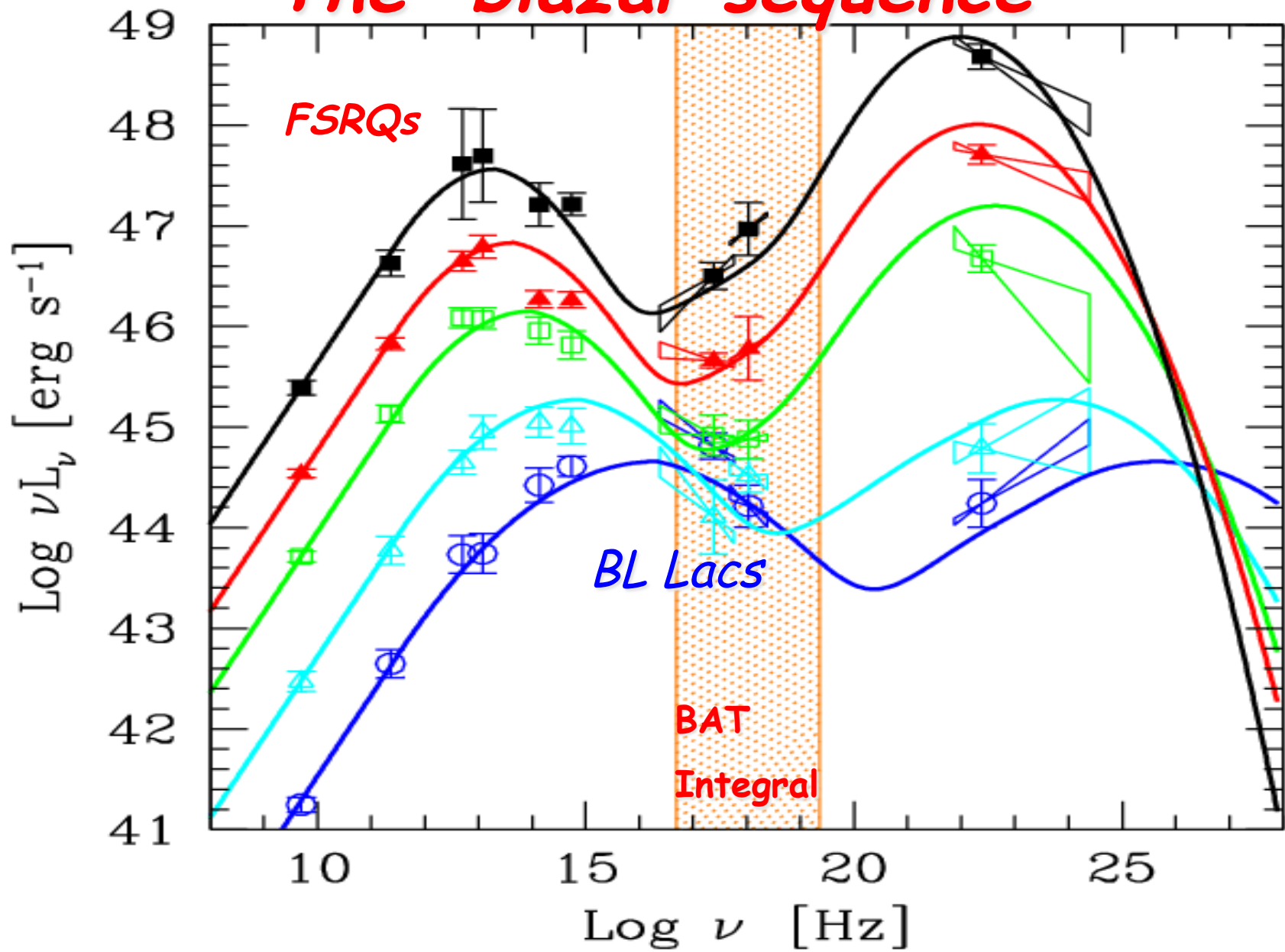
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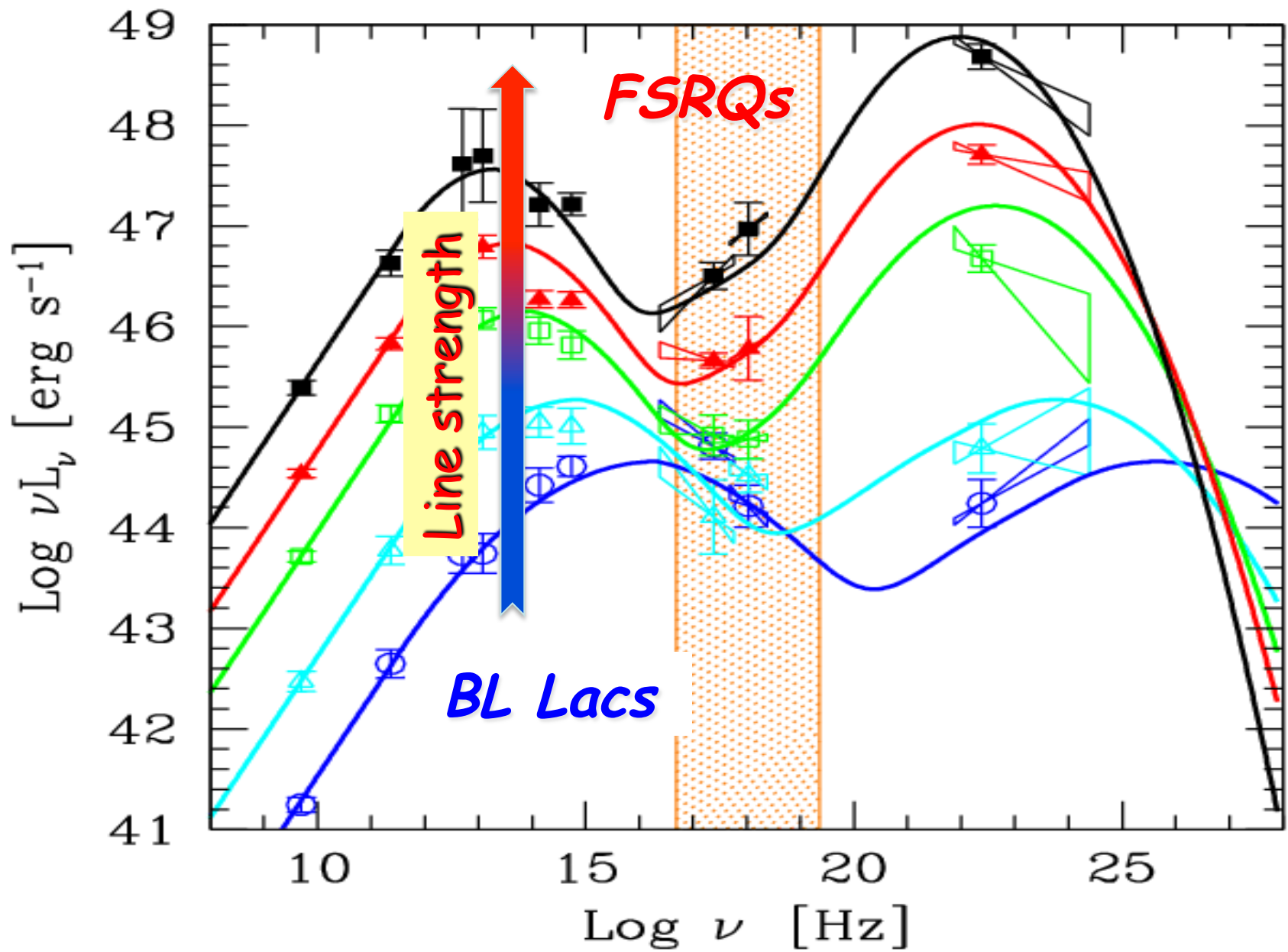
F. Tavecchio,

BL Lacs vs FSRQs: the blazar sequence

The "blazar sequence"

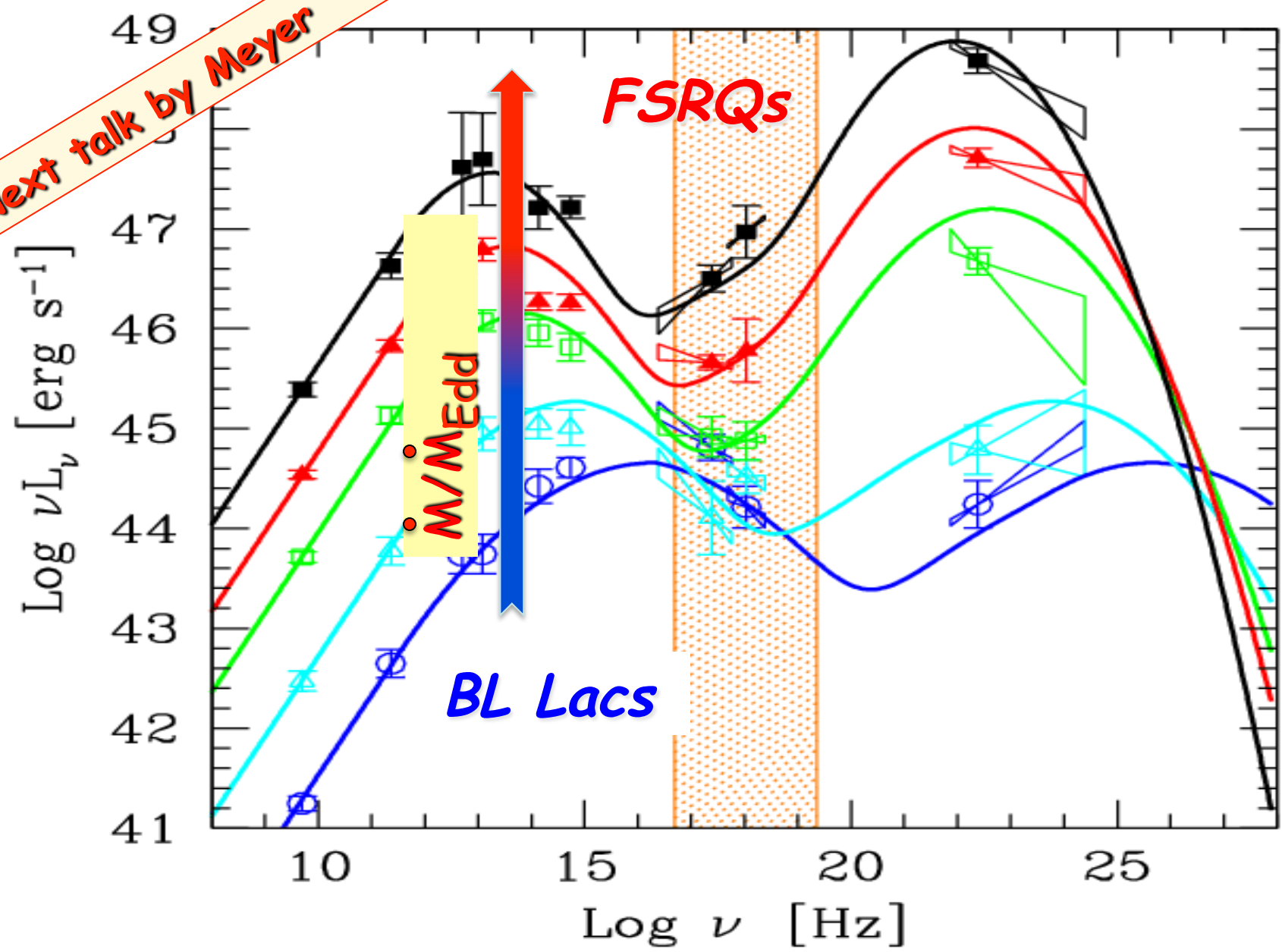


Fossati et al. 1998; Donato et al. 2001



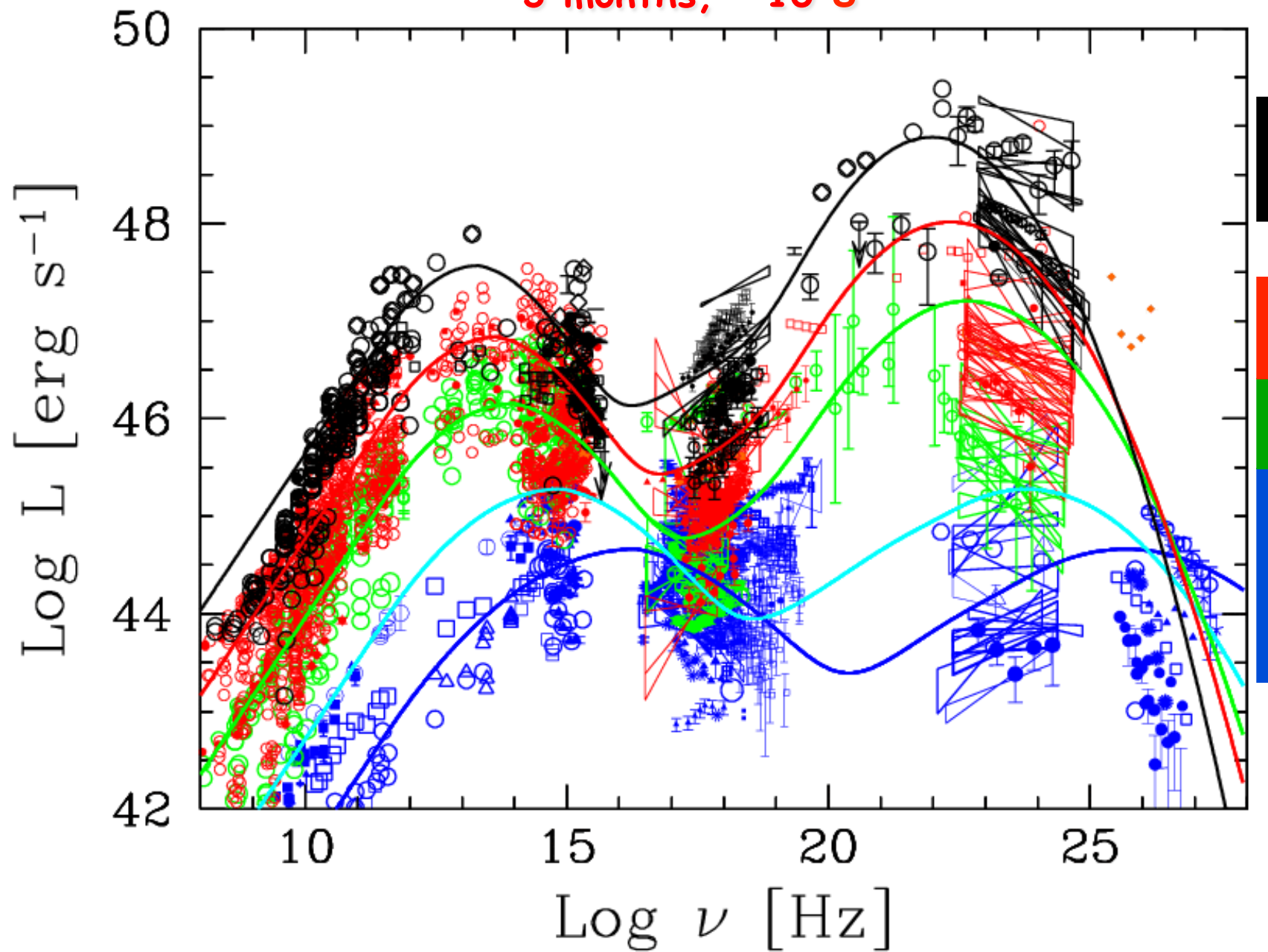
Fossati et al. 1998; Donato et al. 2001

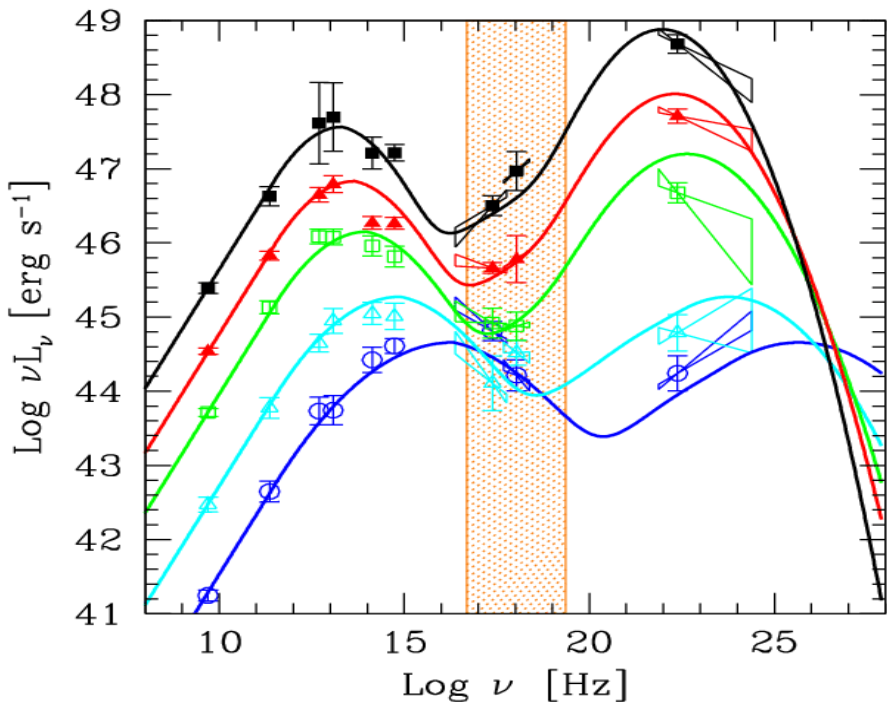
Next talk by Meyer



Fossati et al. 1998; Donato et al. 2001

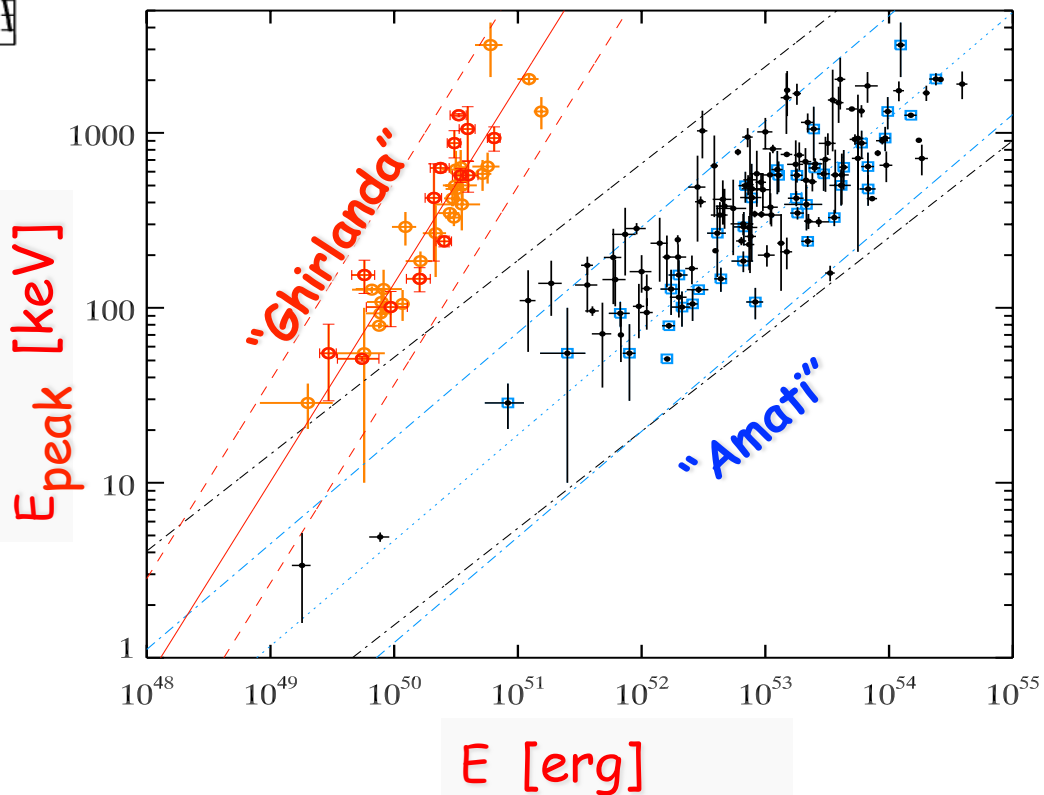
3 months, 10 s





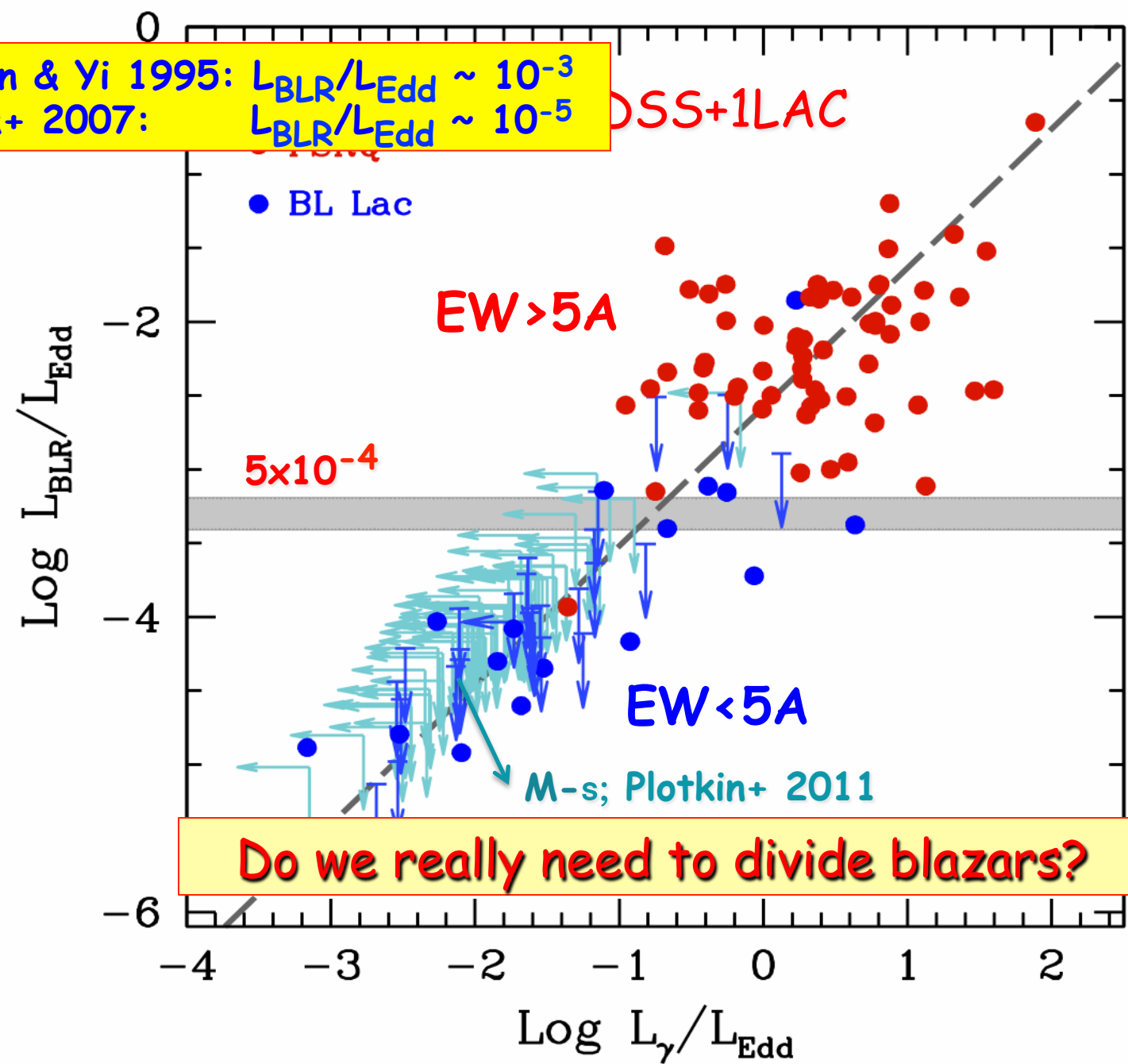
Blazars: the redder the more powerful \rightarrow cooling

GRBs: the bluer the more powerful \rightarrow heating?? G?



Jet-accretion connection & location

Narayan & Yi 1995: $L_{\text{BLR}}/L_{\text{Edd}} \sim 10^{-3}$
Sharma+ 2007: $L_{\text{BLR}}/L_{\text{Edd}} \sim 10^{-5}$



Do we really need to divide blazars?

Sbarrato+ 2011

$L > 0.01 L_{\text{Edd}}$

Big blazars

Leptonic view. For adronic:
next talk by Boettcher

Torus $\sim 1-10$ pc



Sikora

R_{Torus}

R_{BLR}

G

Disk

Broad Line Region
 ~ 0.2 pc

Within R_{BLR}
 $U_{\text{BLR}} = \text{const}$

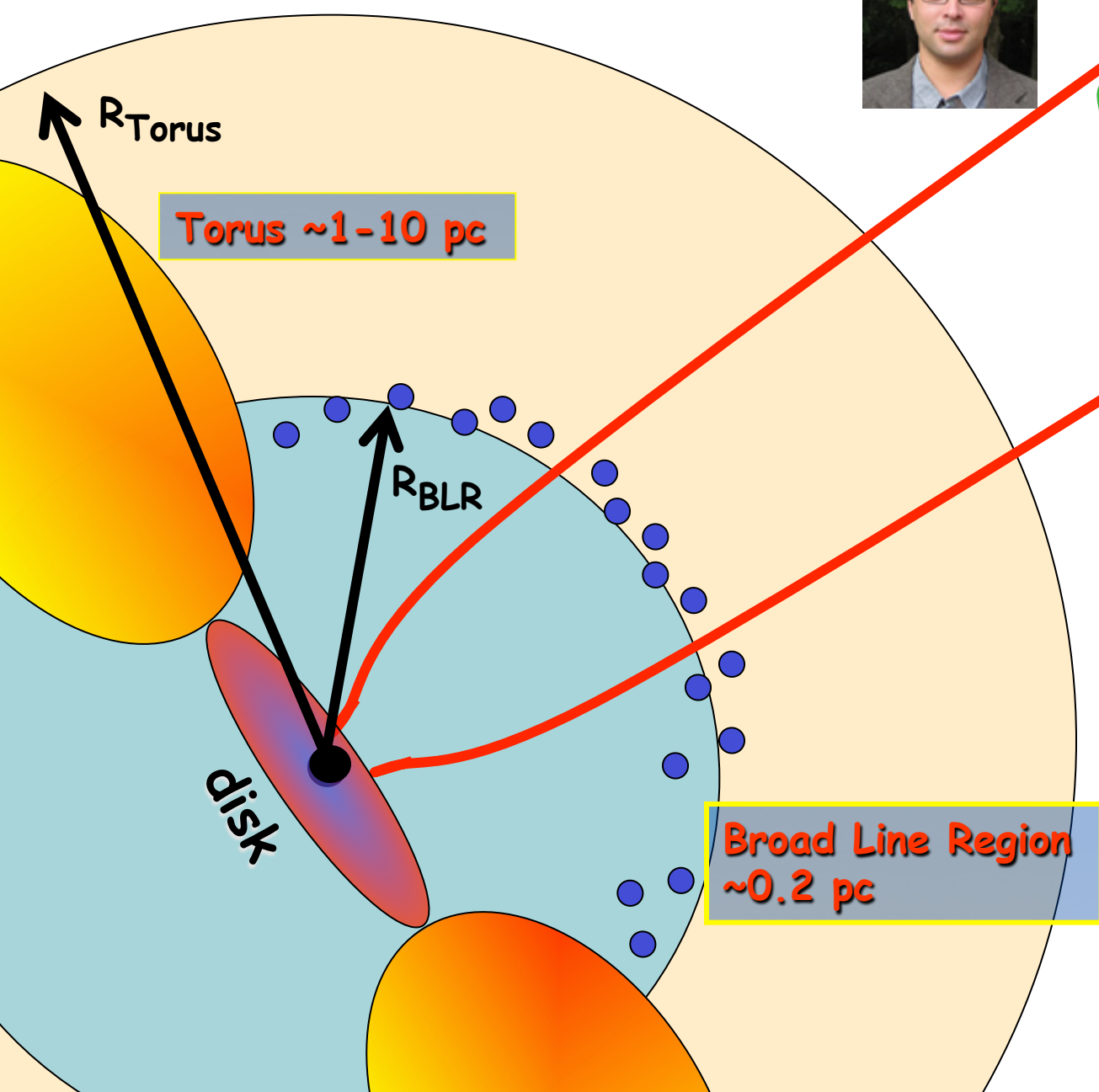
Within R_{Torus}
 $U_{\text{IR}} = \text{const}$

$S_{\text{T}} \sim S_{\text{ggg}}$
HeII



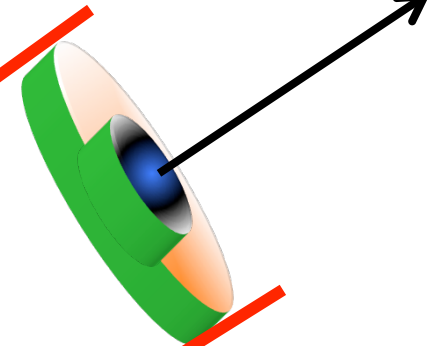
Poutanen

$L > 0.01 L_{\text{Edd}}$



Lyutikov

G



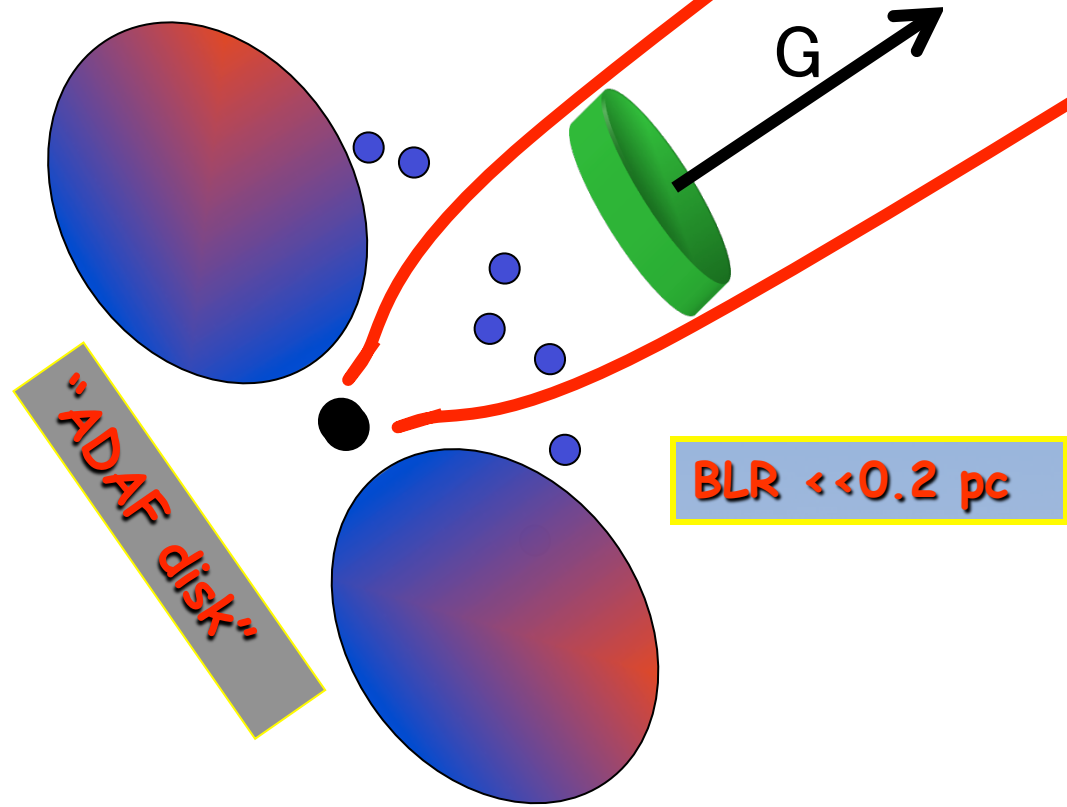
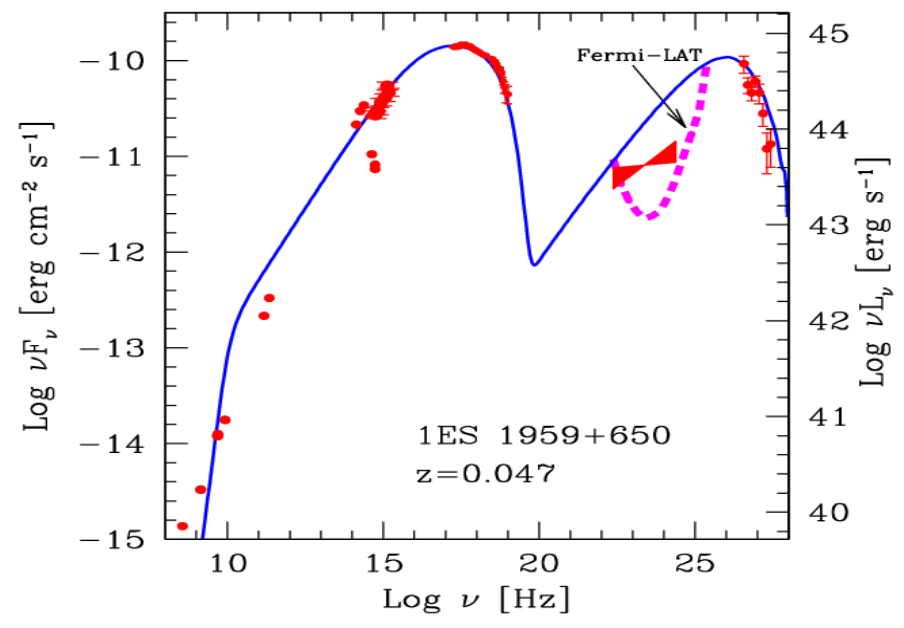
~VLBI region
~20 pc away
(Marscher+)



Also Joshi,
next talk

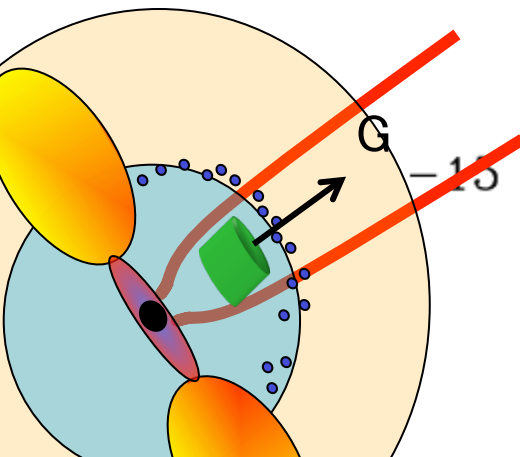
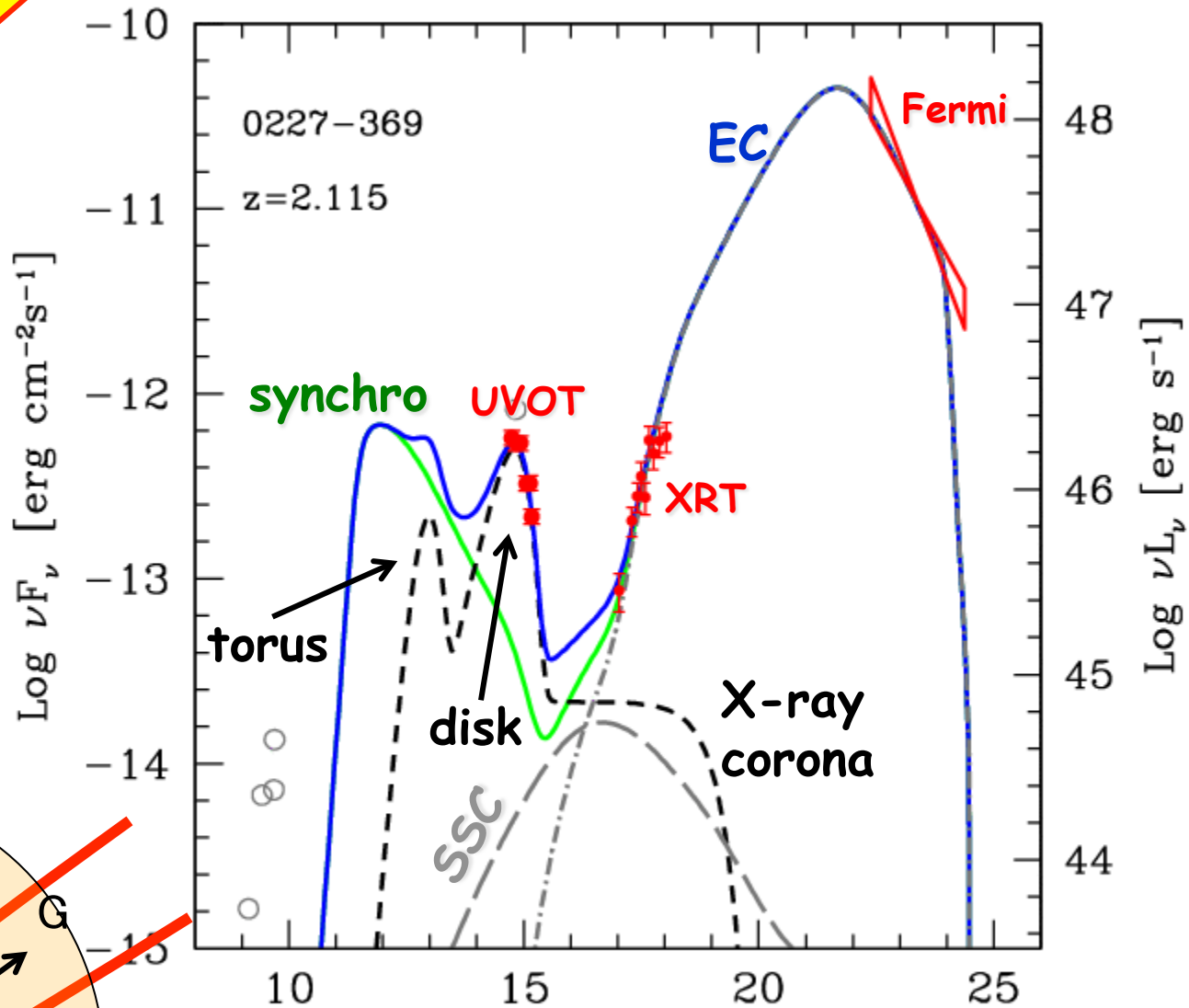
$L < 0.01 L_{\text{Edd}}$

SSC only
weak cooling



Black hole masses (for FSRQs)

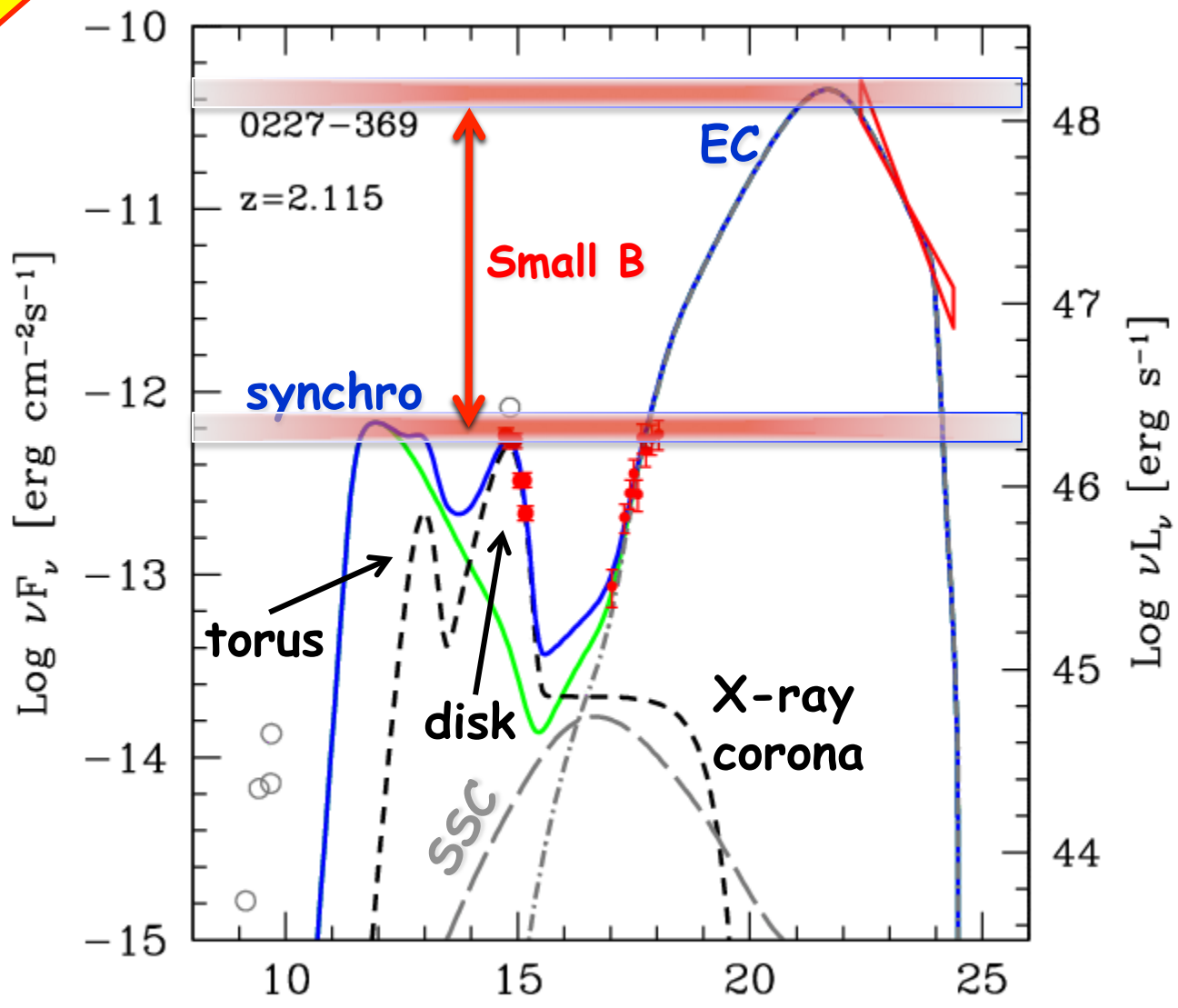
$M_{BH} = 2 \times 10^9$



Low energy synchro peak:
leave the disk naked!

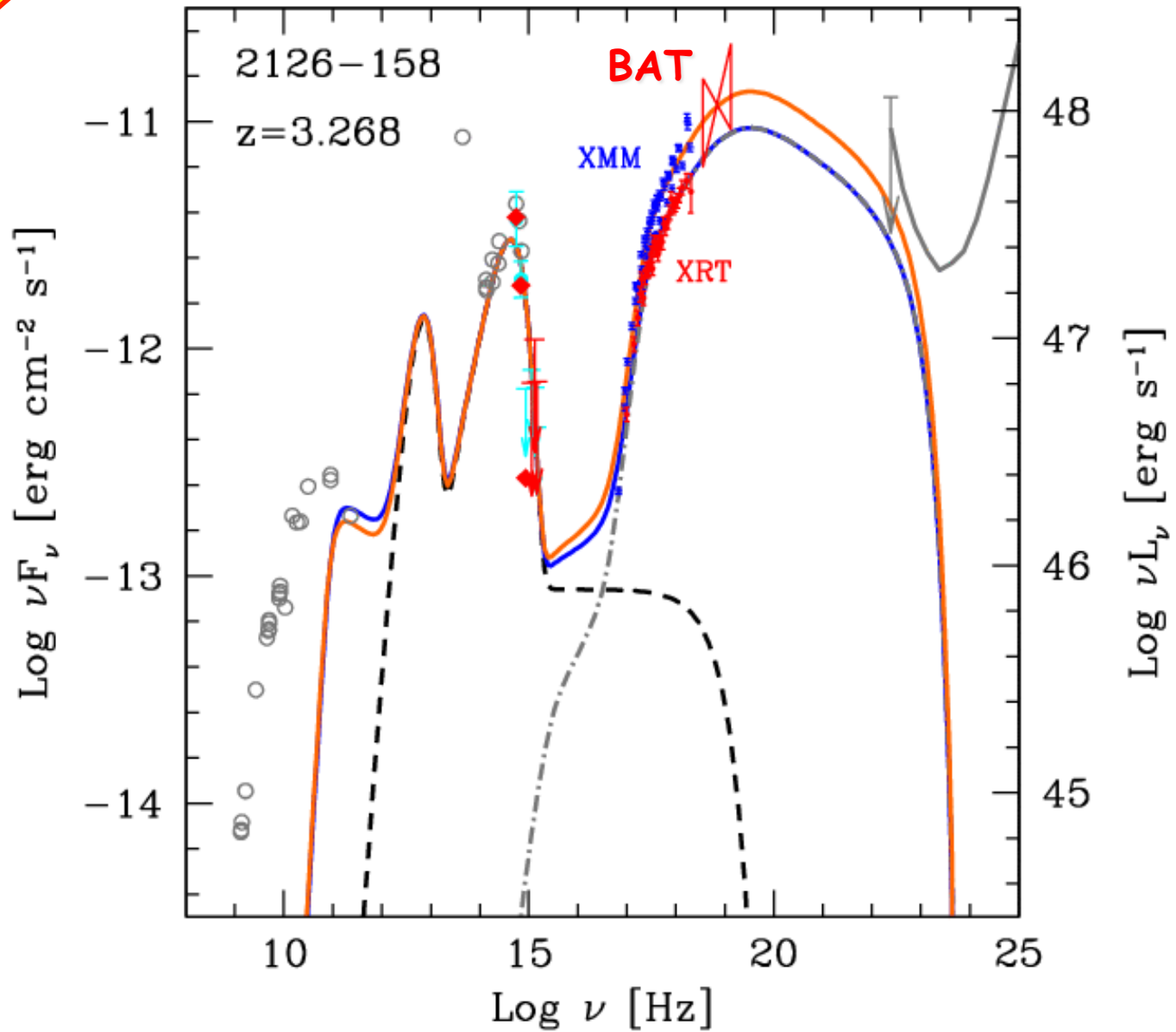
GG, Tavecchio & Ghirlanda 2009

$M_{\text{BH}} = 2 \times 10^9$



GG, Tavecchio & Ghirlanda 2009

$M_{\text{BH}}=10^{10}$



Jet power

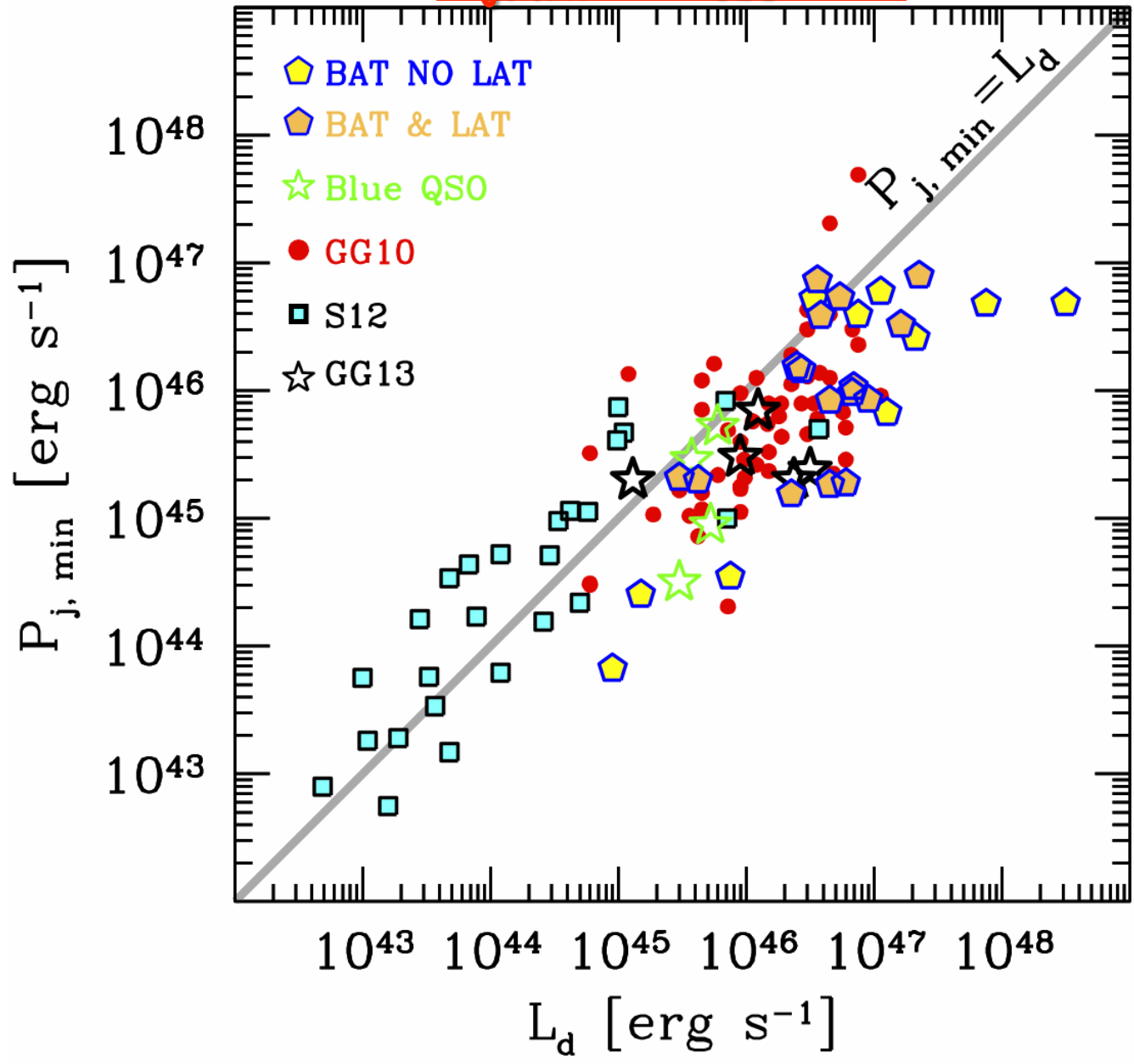
The jet cannot have less power than what required to produce the observed luminosity:

$$P_{\text{jet}} > \frac{L_{\text{obs}}}{G^2}$$

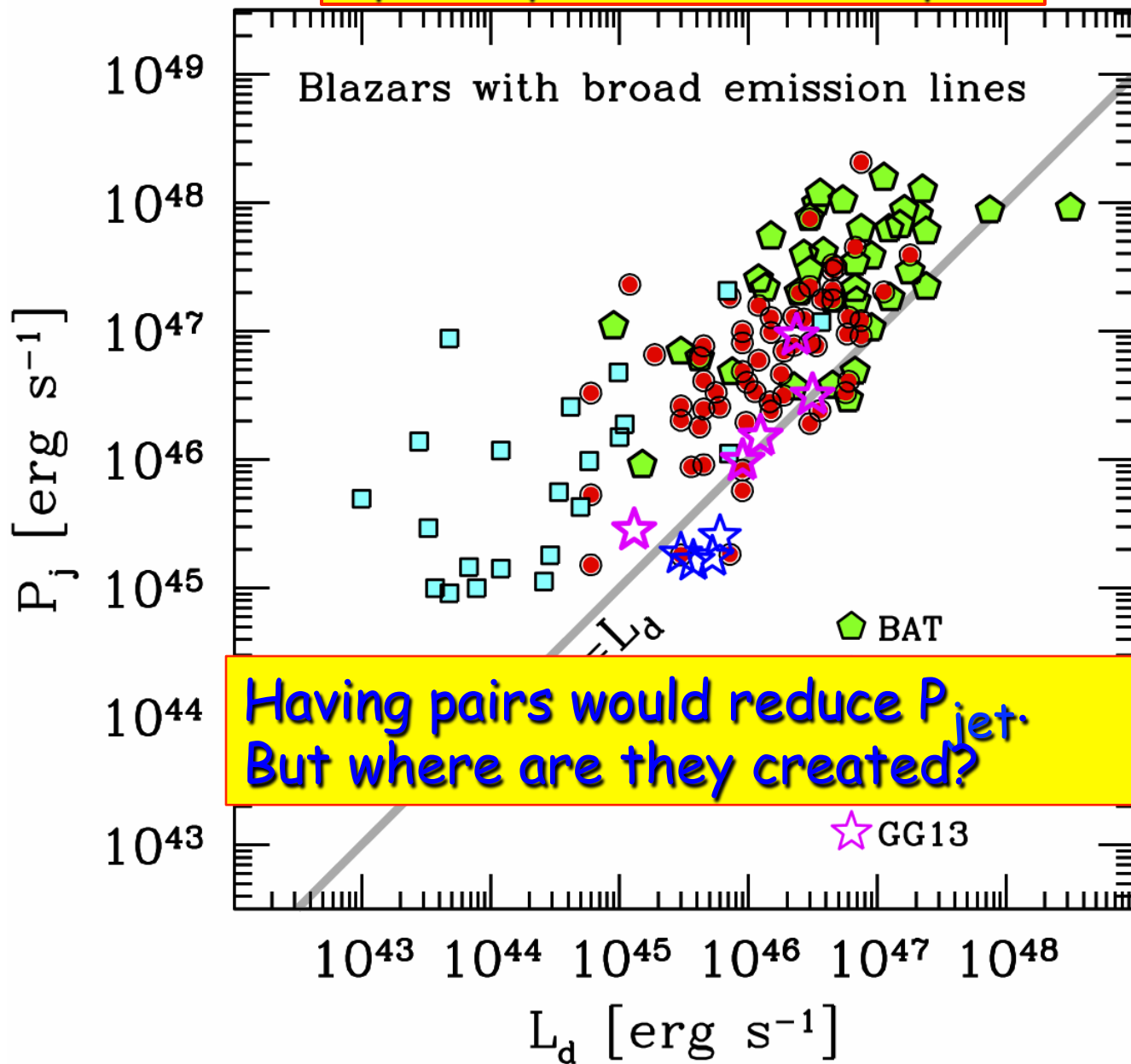
If P_{jet} is twice as much, G halves.
We can take that as the minimum P_{jet} .
This limit is model-independent.

$$P_{j,\min} = 2L_{\text{obs}}/G^2$$

$G \rightarrow G/2$

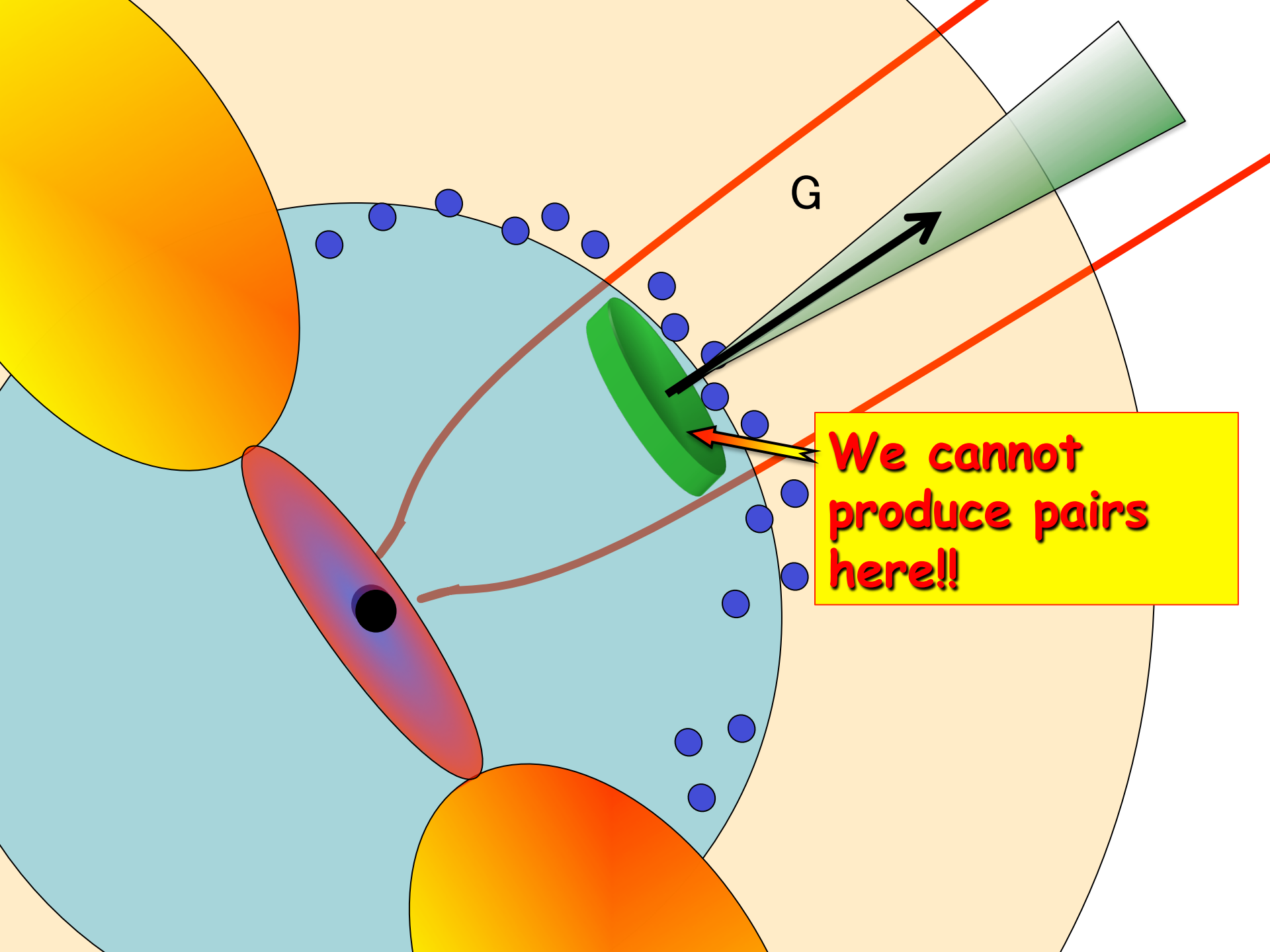


1 proton per electron \rightarrow no pairs



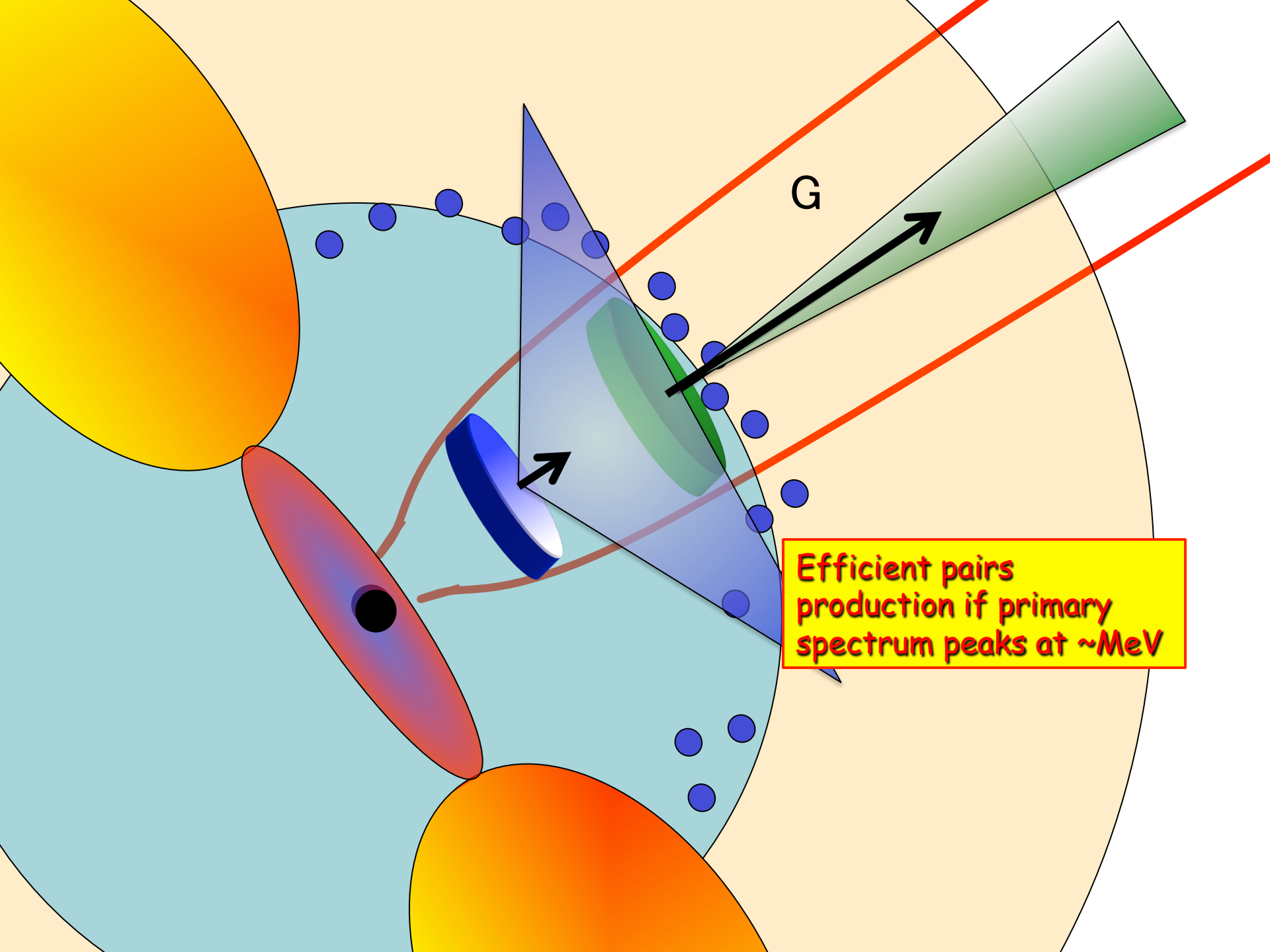
Having pairs would reduce P_{jet} .
But where are they created?

Pairs and radio-galaxies

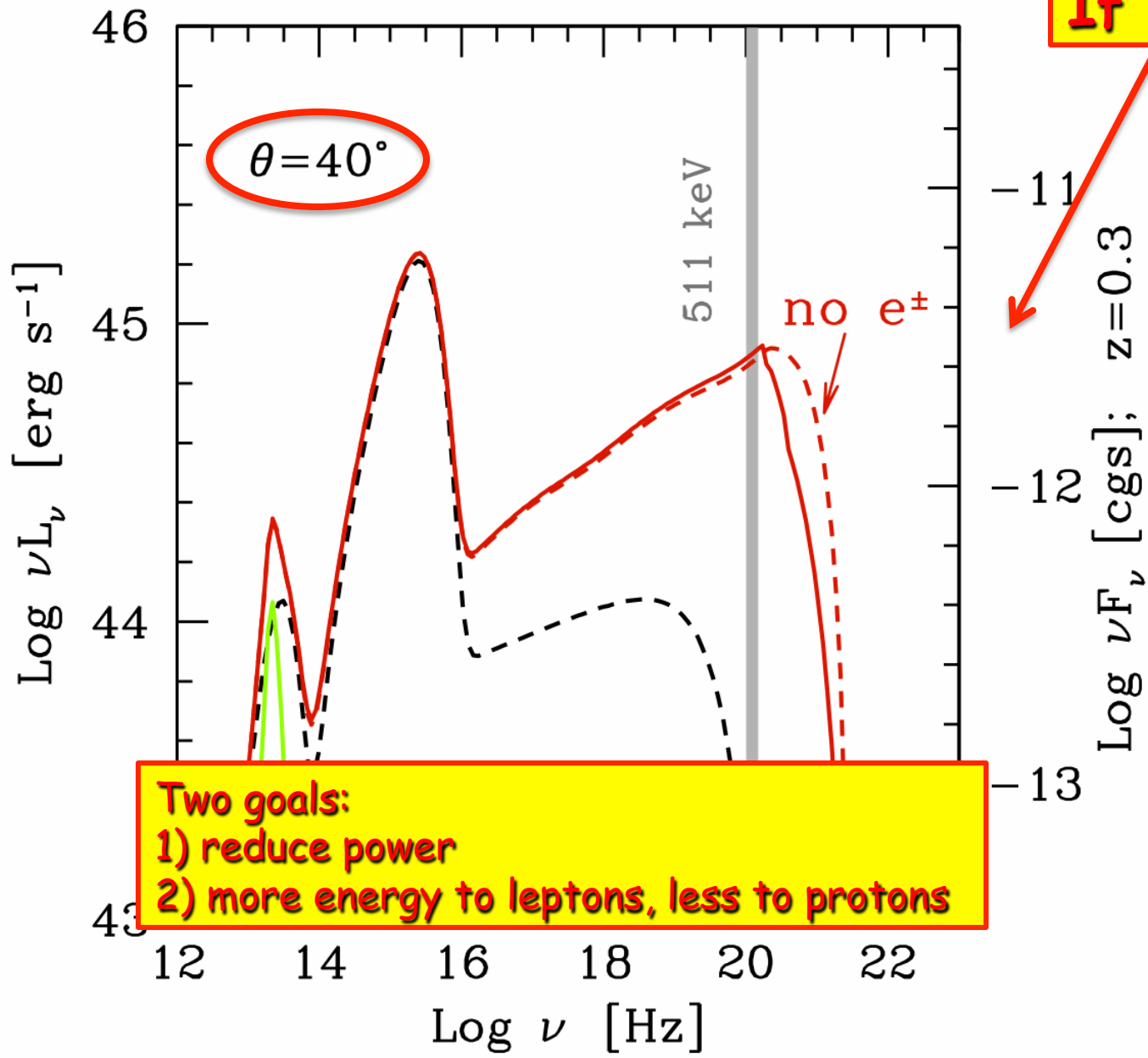


G

**We cannot
produce pairs
here!!**



Efficient pairs
production if primary
spectrum peaks at \sim MeV



Two goals:
 1) reduce power
 2) more energy to leptons, less to protons

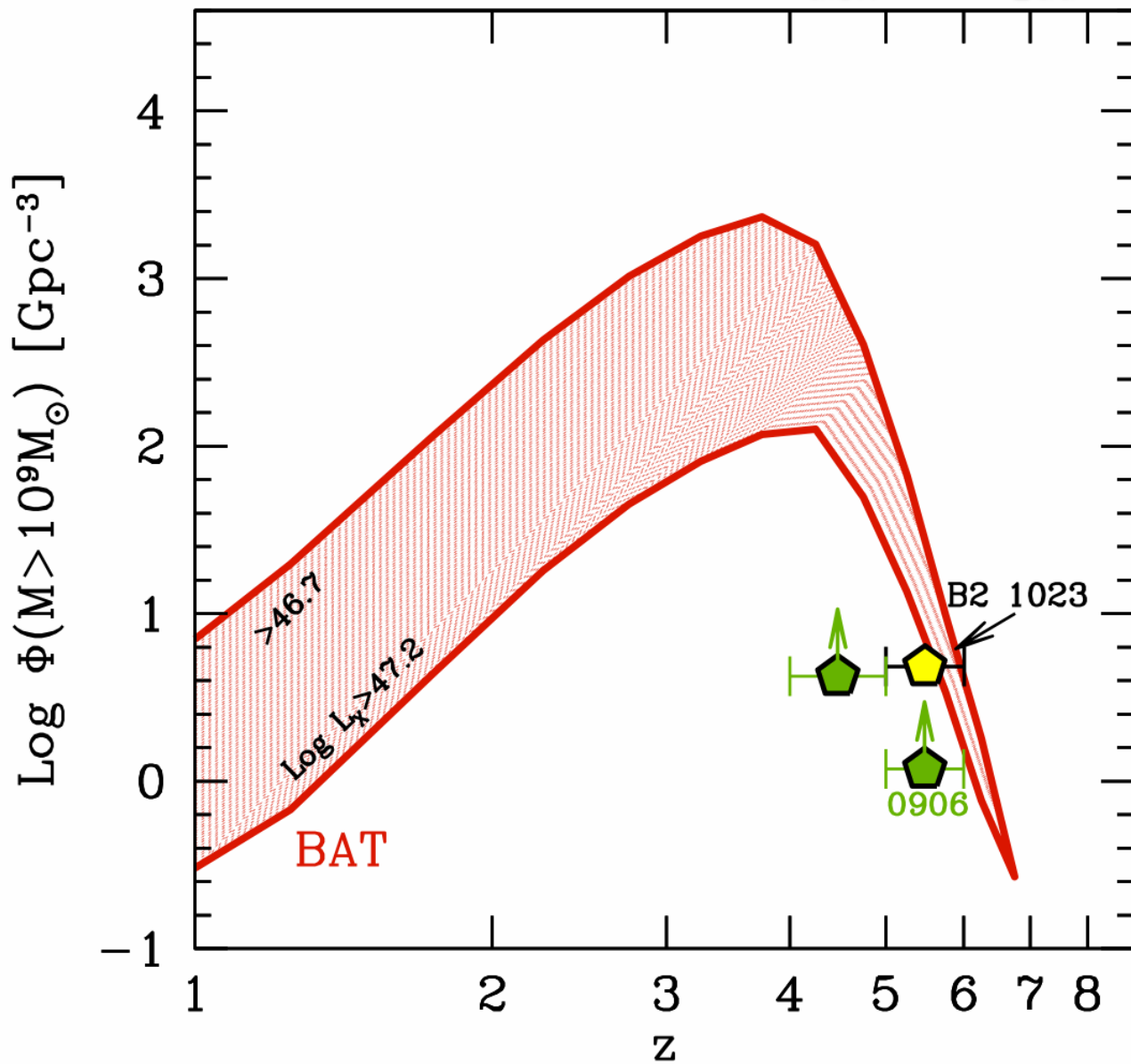
Two epochs of heavy
BH formation?

Recently, two complete surveys of blazars: BAT and LAT (Ajello+2009, 2012).

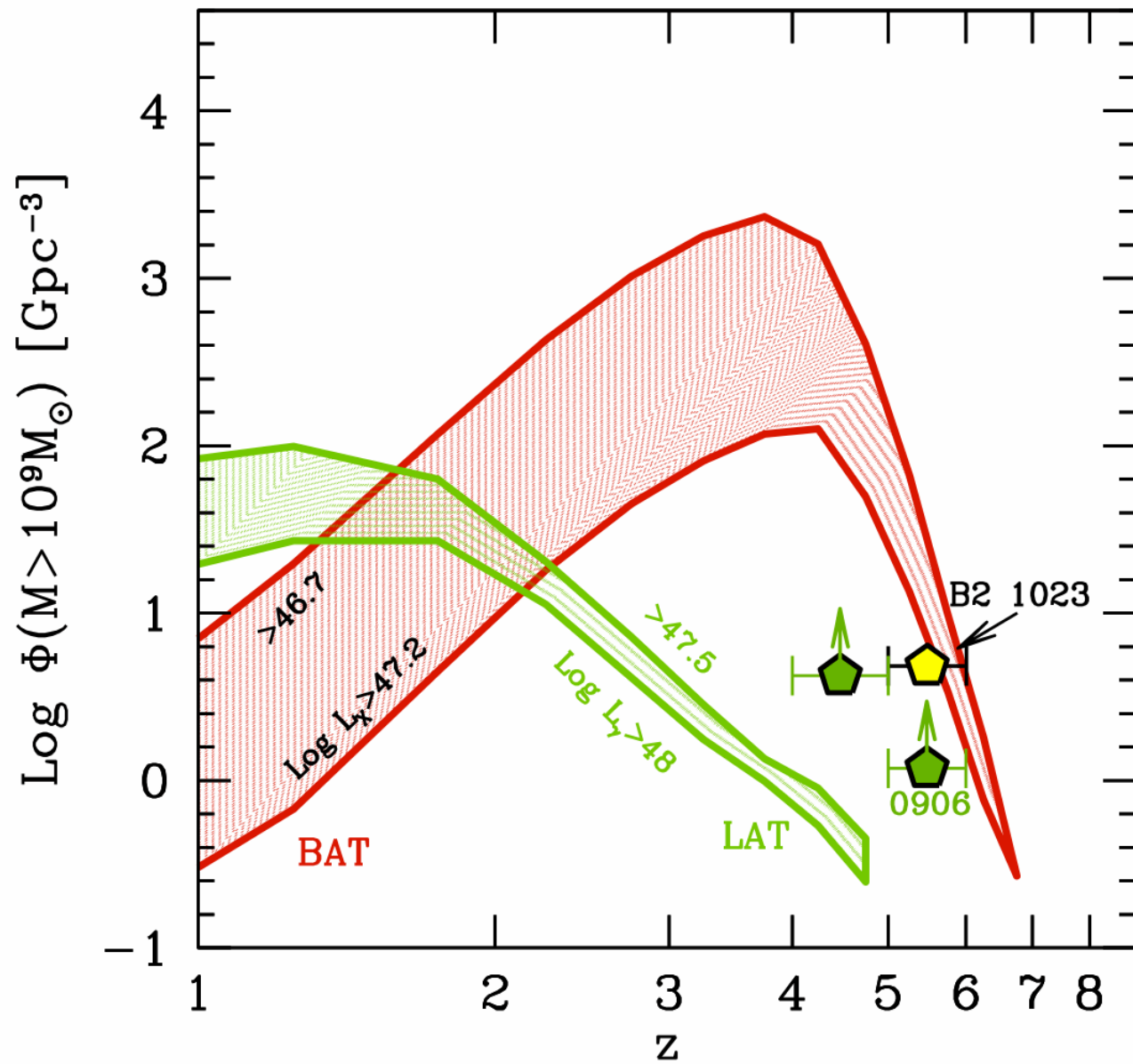
BAT has fewer blazars, but more at high redshifts.

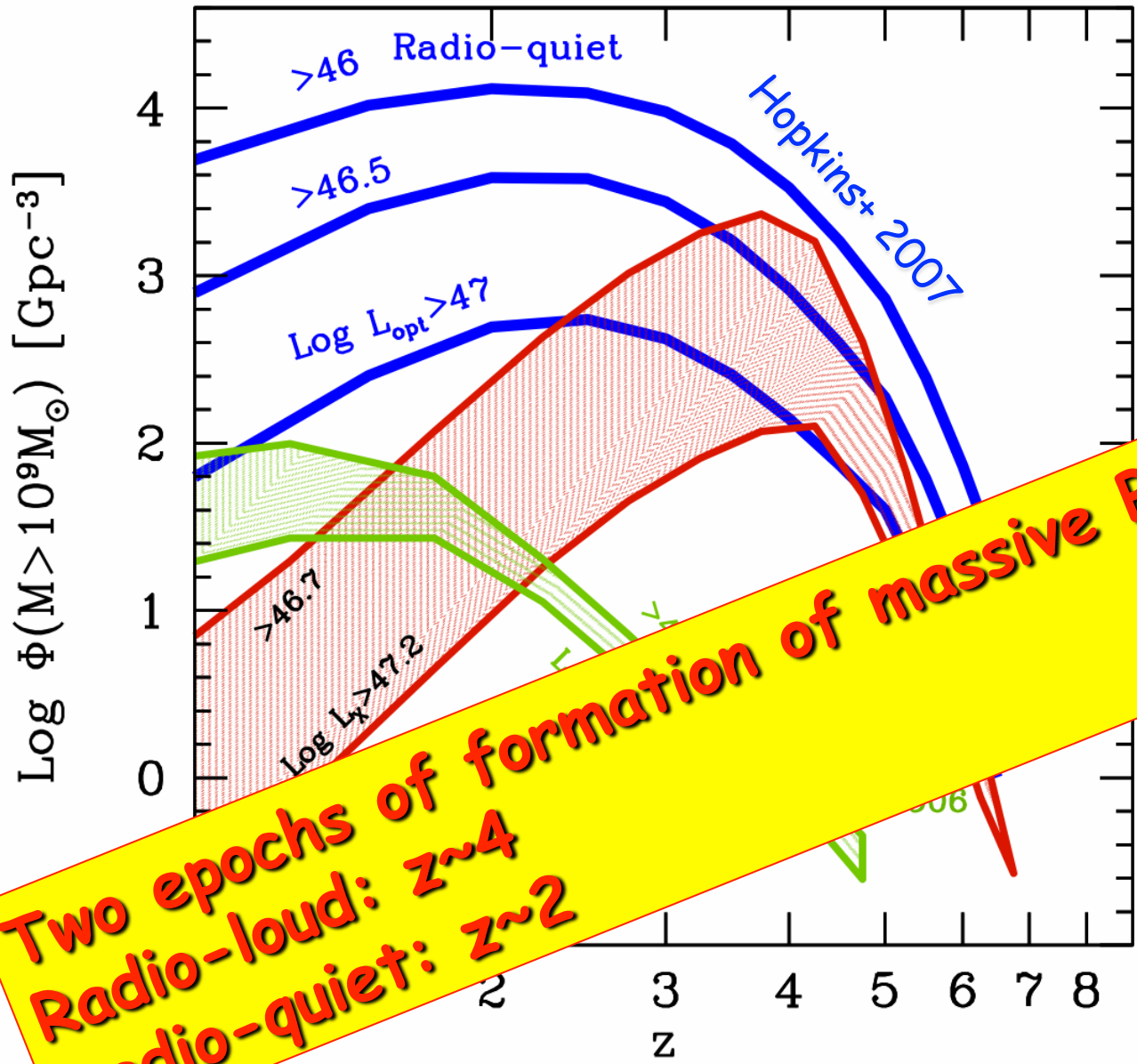
All BAT blazars at $z > 2$ have $M_{\text{BH}} > 10^9 M_{\odot}$.
These all have $L_x > 10^{47}$ erg/s and
 $L_{\text{disk}} > 0.1 L_{\text{Edd}}$

Heavy & Active: $M > 10^9$; $L_{\text{disk}} > 0.1 L_{\text{Edd}}$



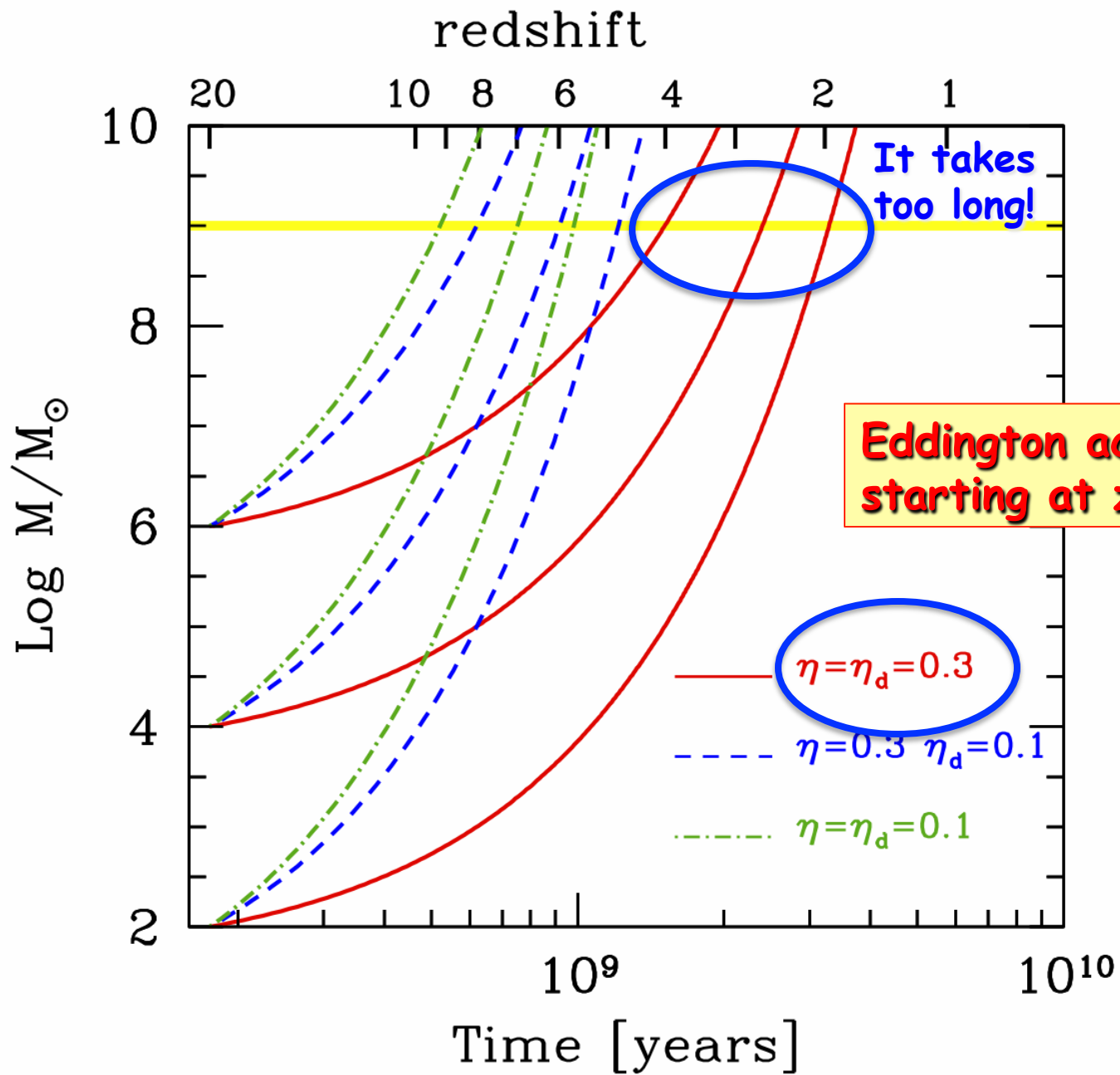
GG+2010, Volonteri+ 2012; GG+ 2013





Two epochs of formation of massive BH?
Radio-loud: $z \sim 4$
Radio-quiet: $z \sim 2$

**Jets → spin → high
accretion efficiencies
→ slow growth**



Conclusions

- Jets for all $\dot{M}/\dot{M}_{\text{Edd}}$
- Location is an issue
- Look if radio-galaxies peak at ~ 1 MeV with $L \sim 10^{45}$ erg/s
- Heavy BH in jetted AGNs form earlier
- Jets & Spin? Something must be changed