EGRET discovery of Gamma-ray blazars

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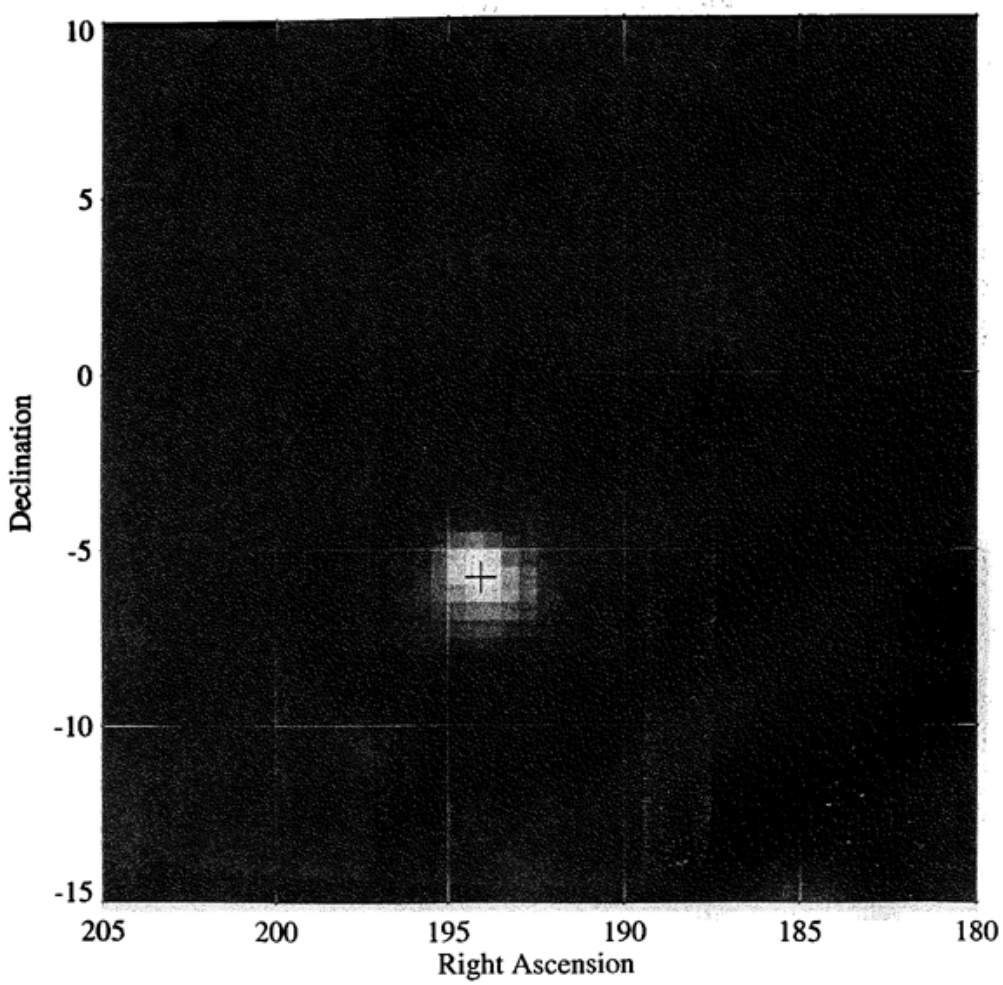
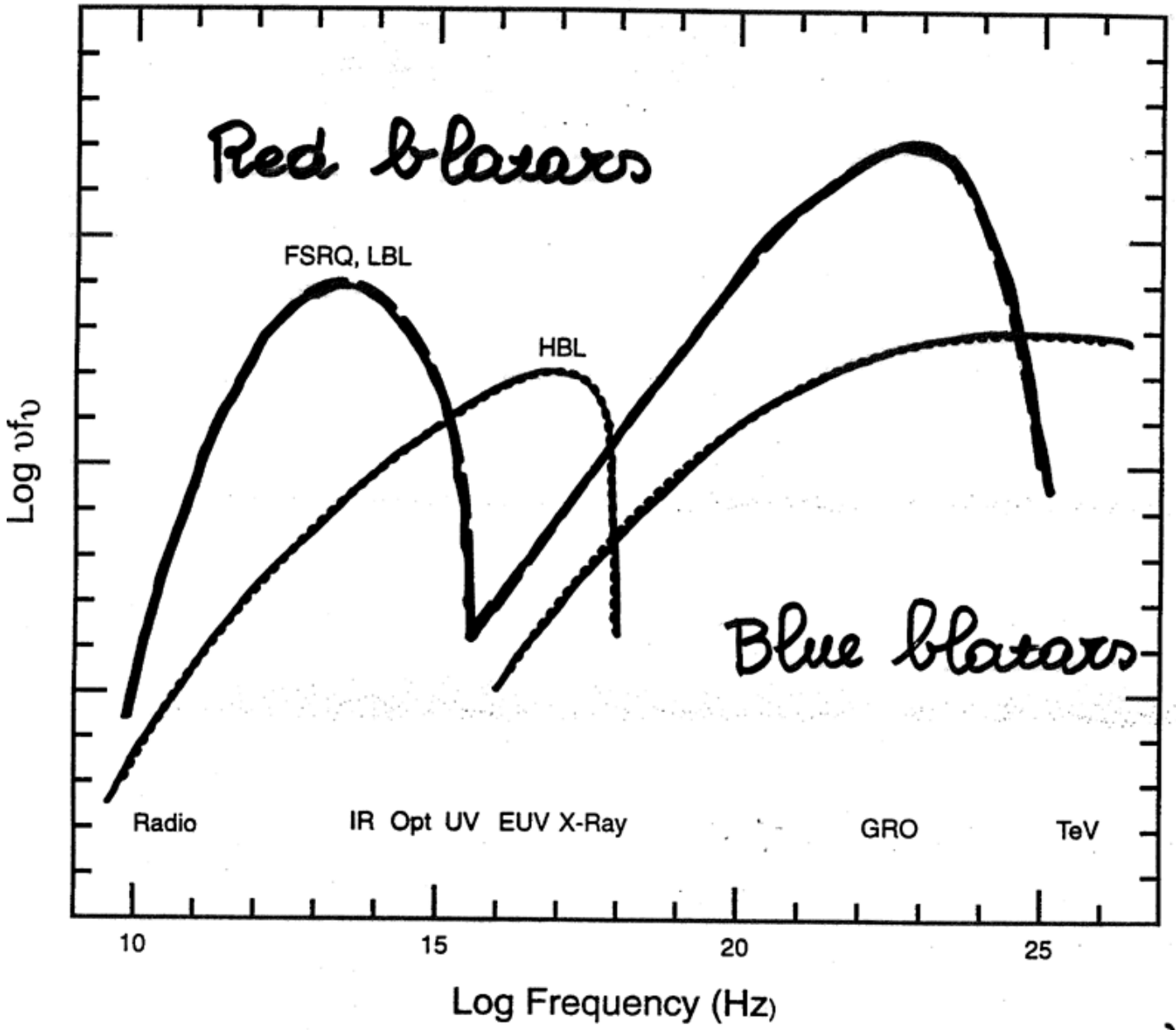
George Mason Univ.



3C 273

3C 279

RMS



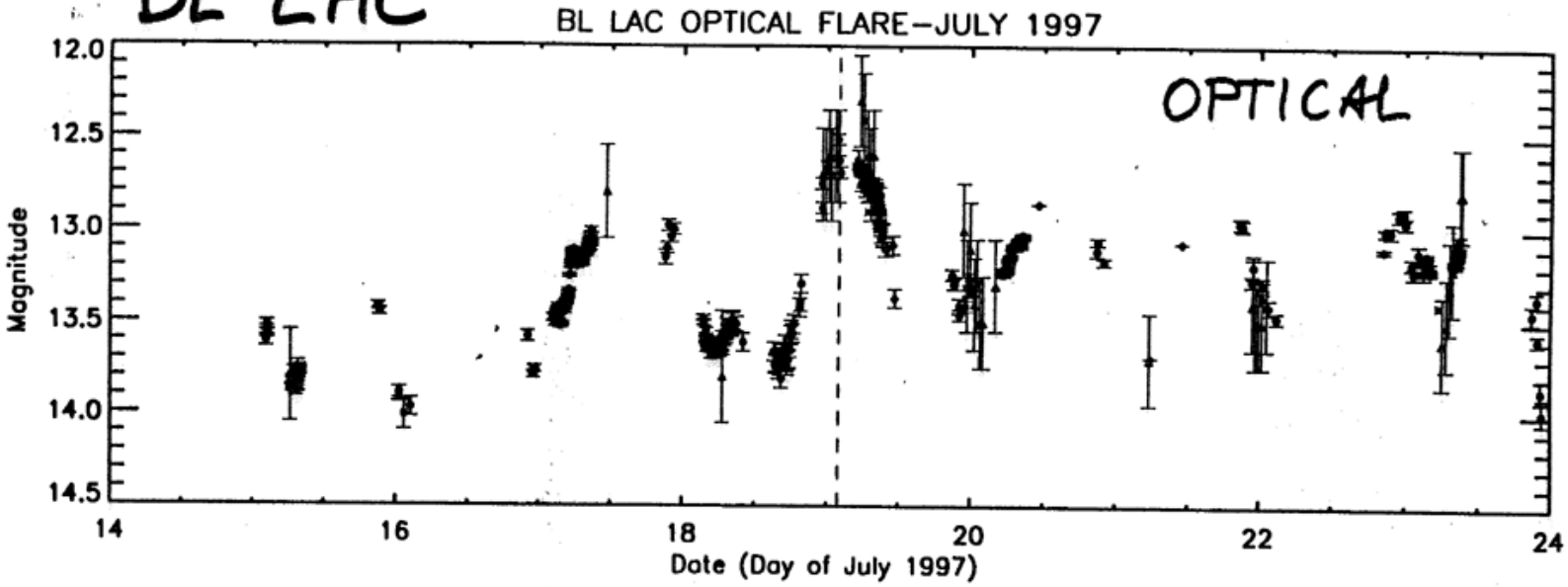
- synchrotron + ? inverse Compton (SSC, EC)

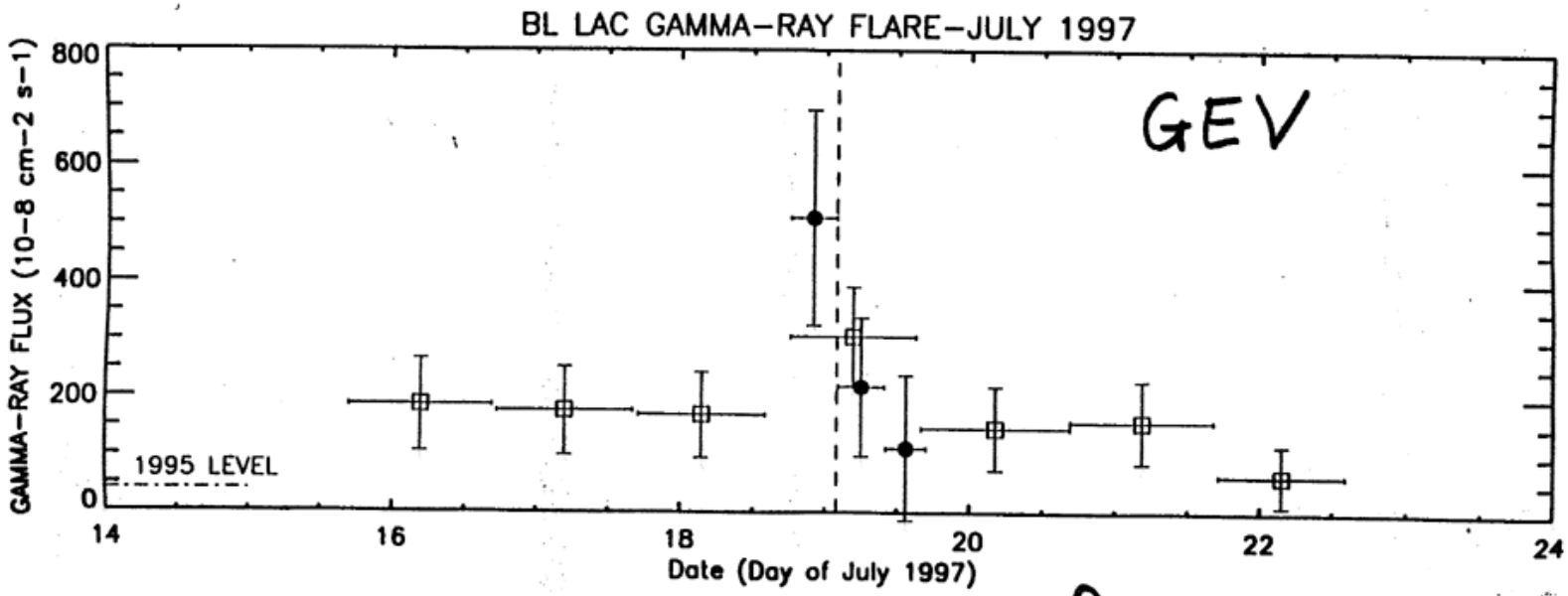
PIC

RMS

Date

BL LAC

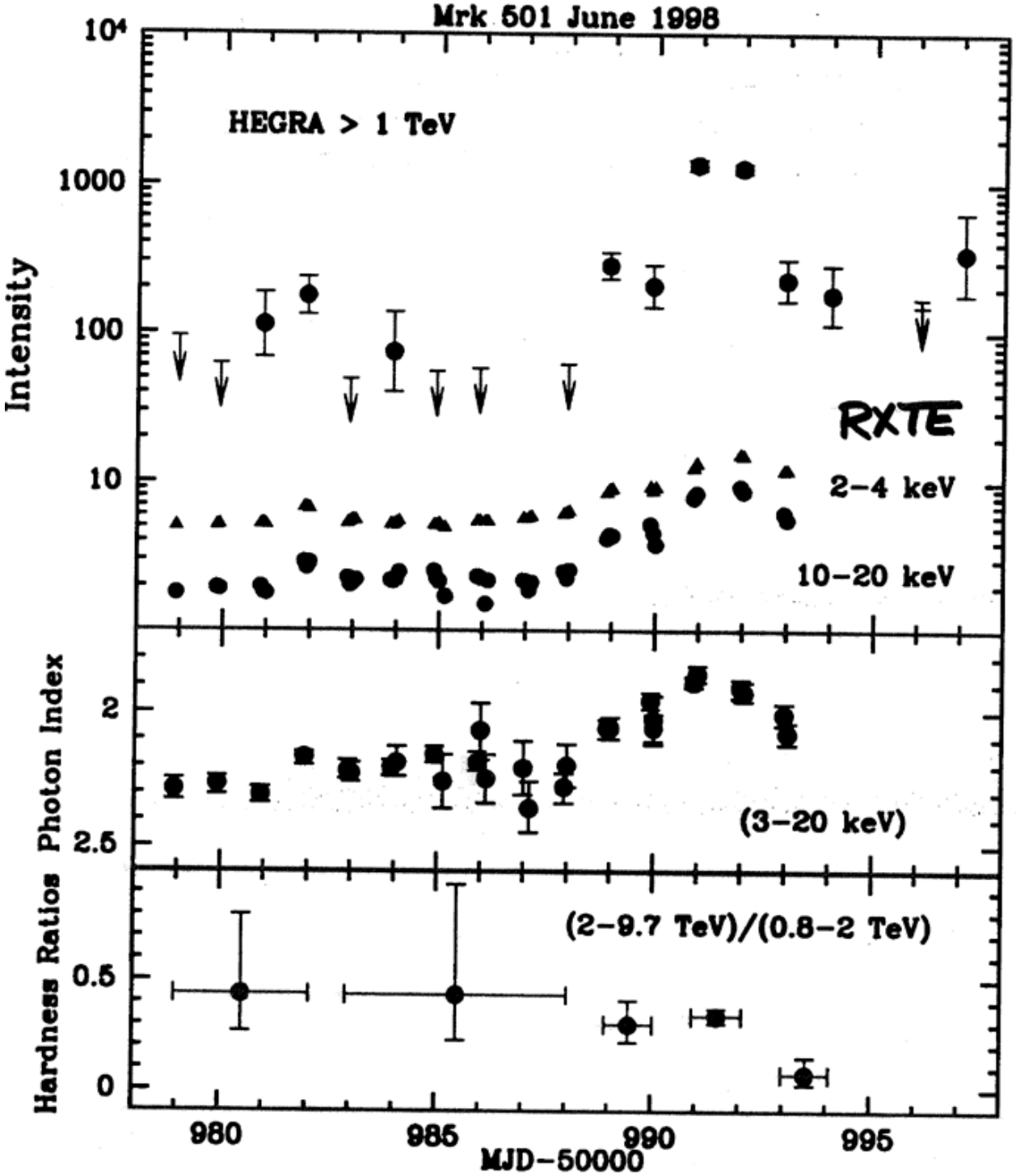




KTS

Bloom et al. 1998

RMS



Sambruna + 2000

RMS

Synchrotron peak frequency

$$\nu_s \propto \gamma^2 B$$

IC peak frequency

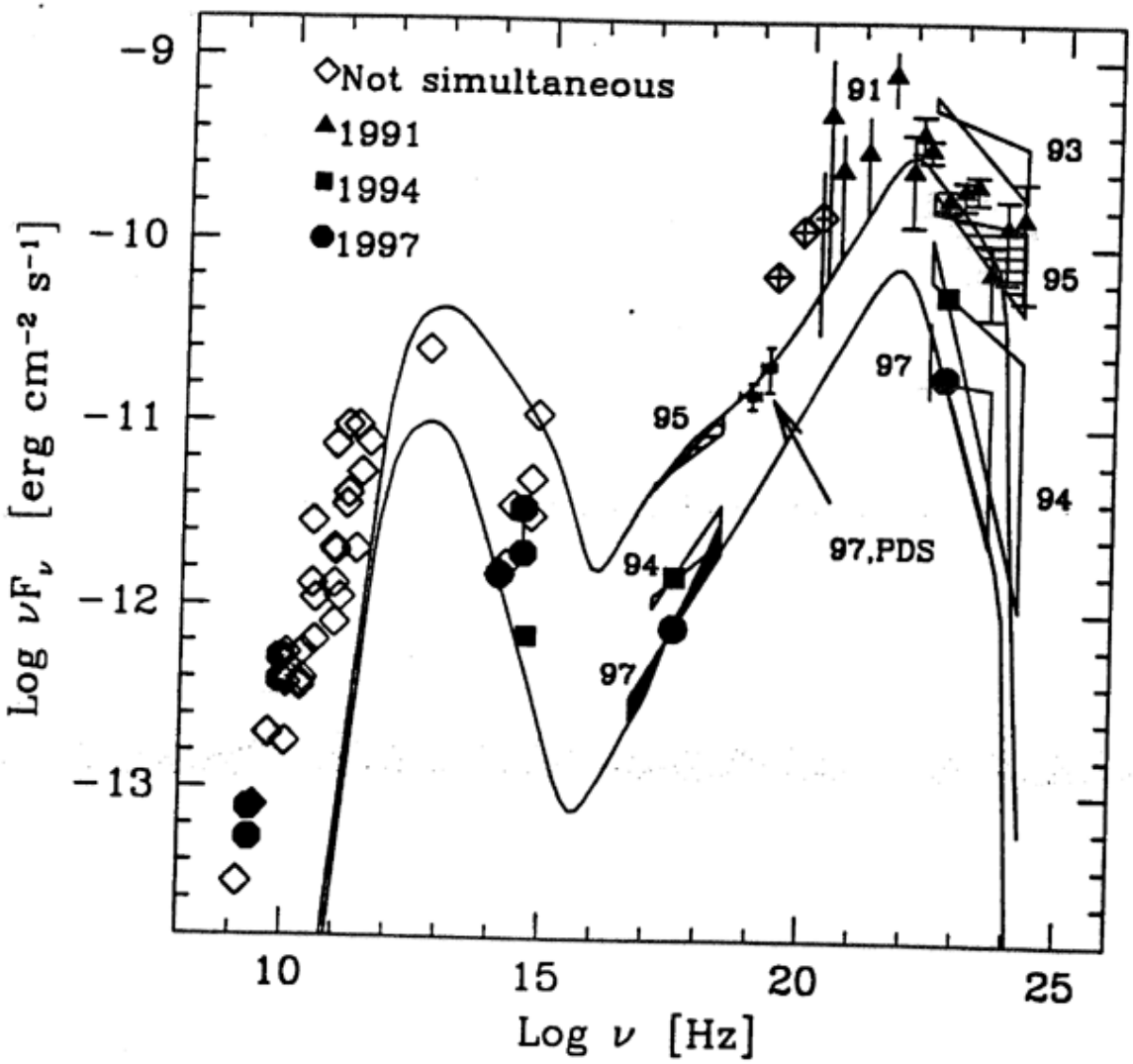
$$\nu_{IC} \propto \begin{cases} \gamma^4 B & \text{SSC} \\ \gamma^2 \nu_{Ext} & \text{EC} \end{cases}$$

1) $$\frac{\nu_{IC}}{\nu_s} \propto \begin{cases} \gamma^2 & \text{SSC} \\ \dfrac{\nu_{Ext}}{B} & \text{EC} \end{cases}$$

2) $$\frac{L_{IC}}{L_s} \propto \frac{U_{en,photons}}{U_B}$$

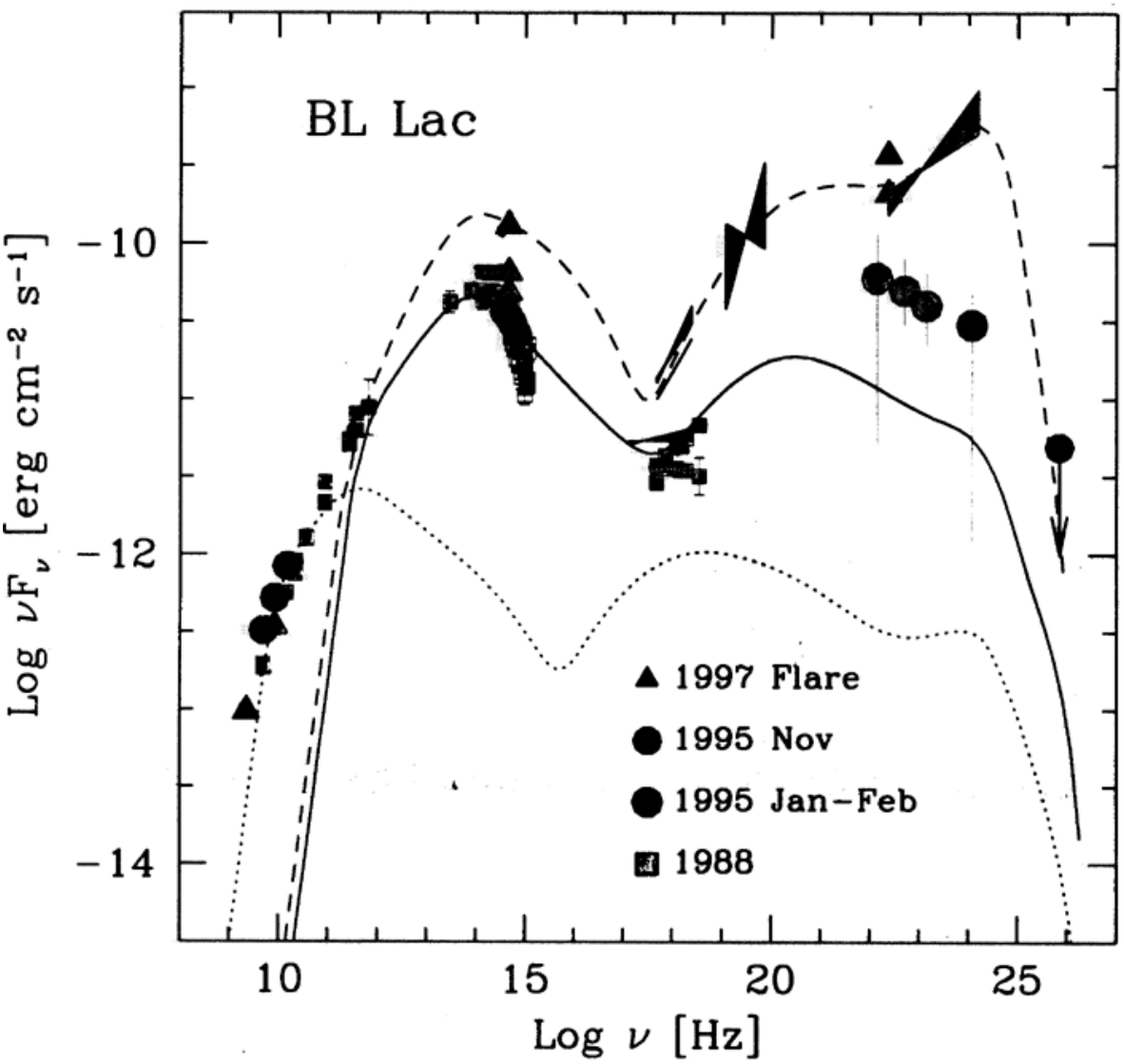
RMS

PKS 0528+134



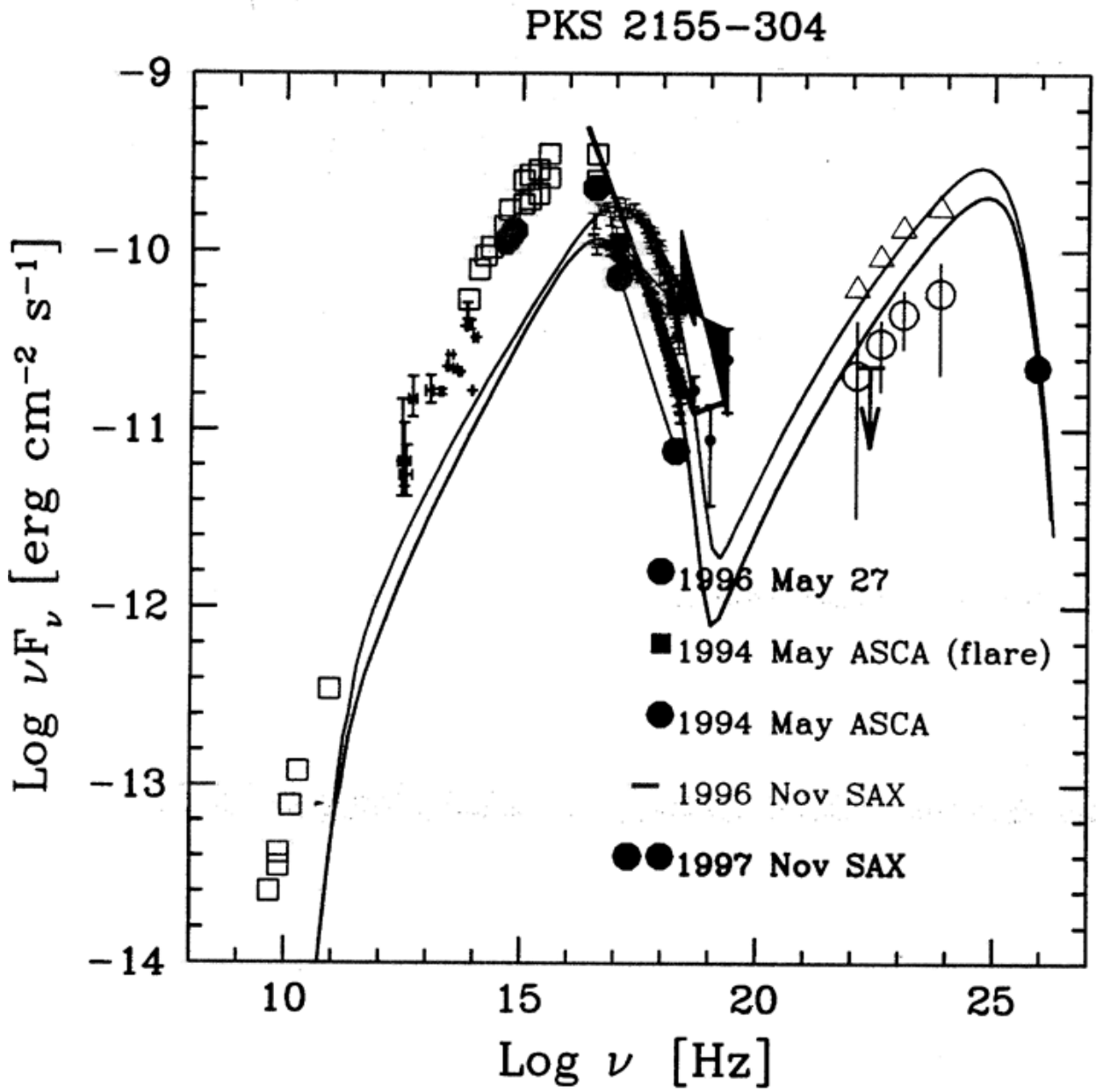
Ghisellini + 98

RMS



Sambruna et al. 98

RHS

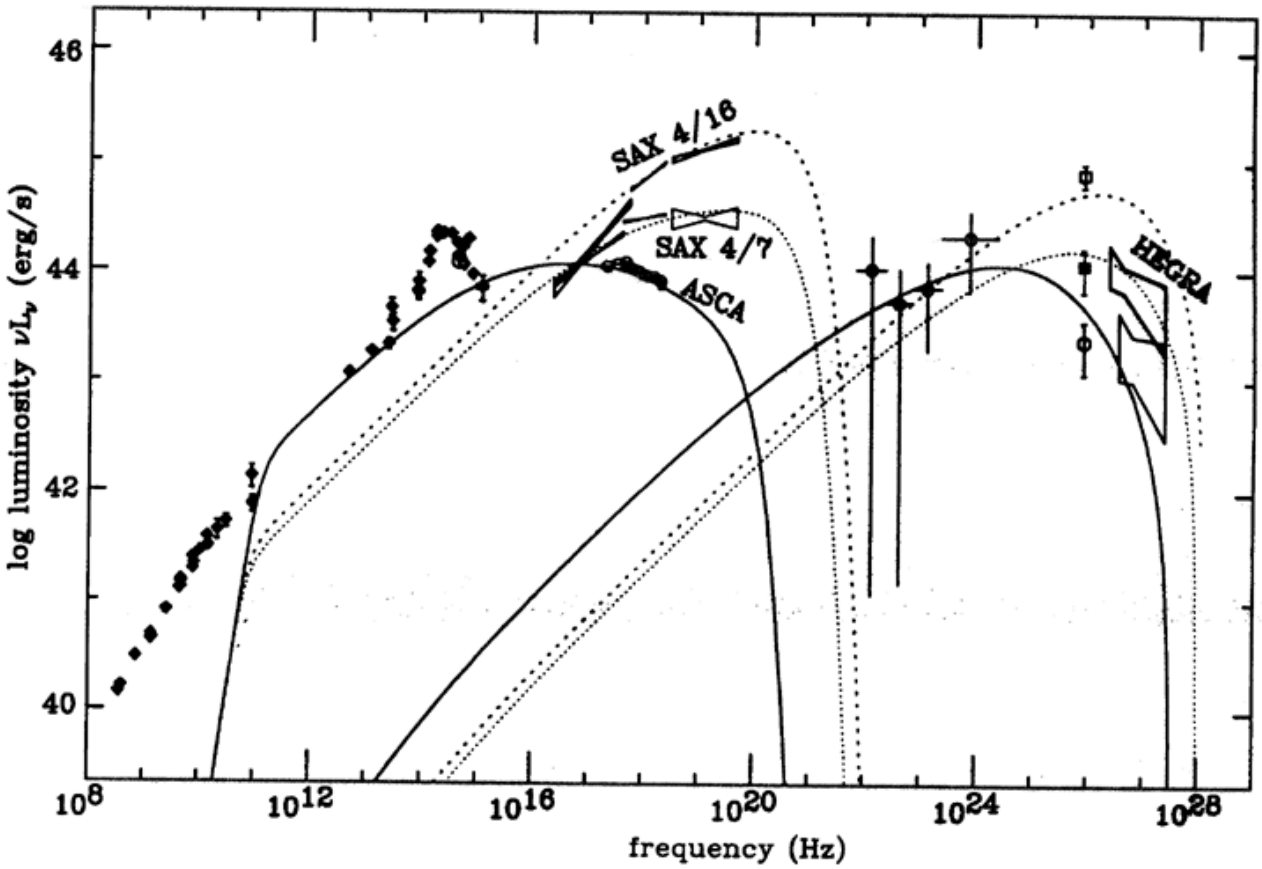


Bertone + 1999

● ● April 1997
● March 1996
● Literature

RHS

Mrk 501



Kataoka + 1999

RMS

Essential λ bands

	ν_s	ν_{IC}
Red bl.	IR OPT	keV - GeV Integral, Astro GLAST
Blue bl.	UV X	MeV - TeV GLAST HESS, VERITAS, MAGIC, CELESTE, STACEE,

Cross-Calibration important!

RMS

GLAST observations of blazars

Red bl

curved γ spectra
large γ vblty @ higher E

Blue bl

flatter γ spectra
lower γ vblty.

cf Synchro + IC

How will we use GLAST? RMS

Conservative approach:

"famous" targets (3C 279, OJ 287, ...

intensive monitoring

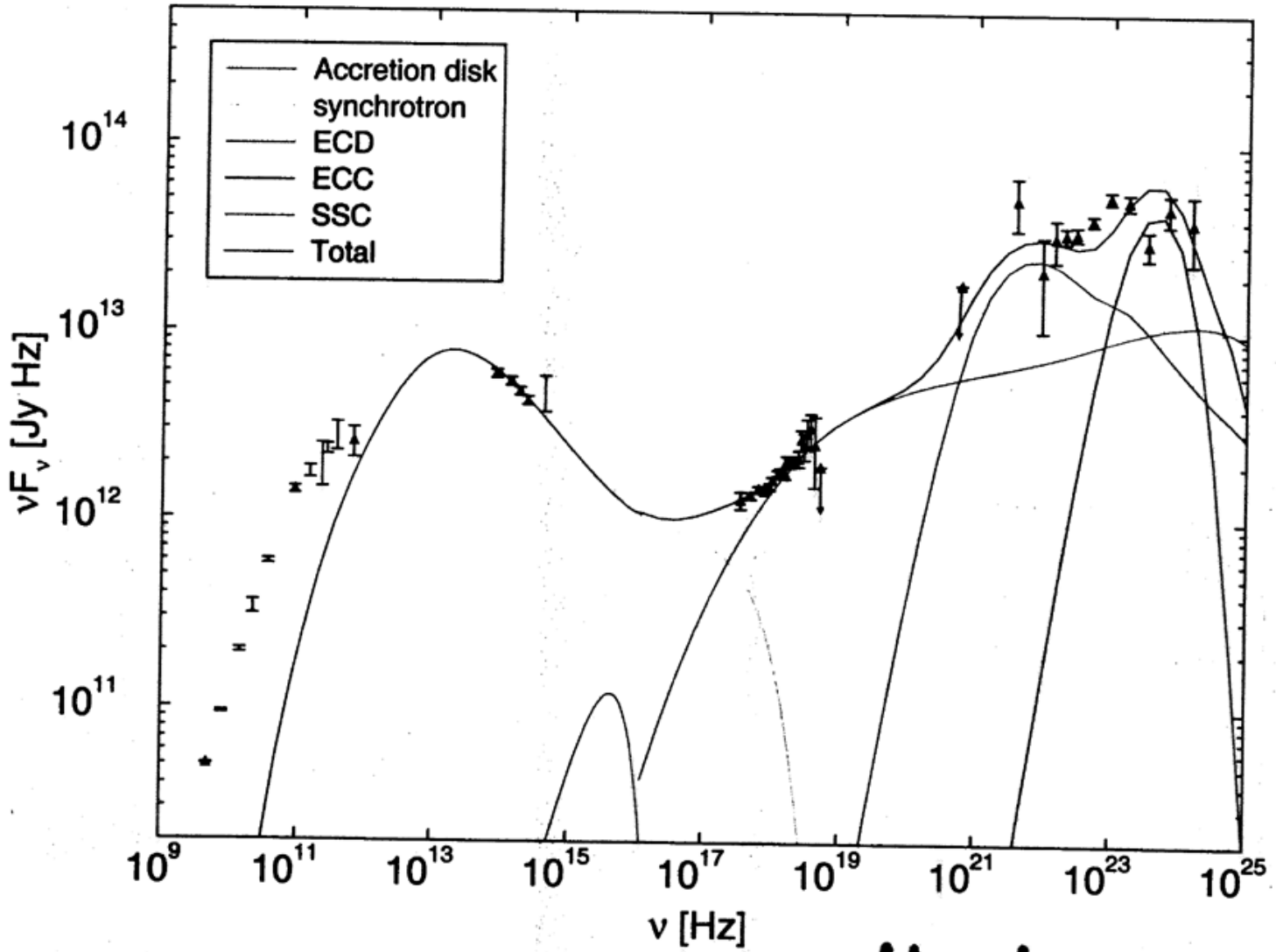
high / low states

- Origin of γ → detailed γ + $\lambda\lambda\lambda$ spectra
- structure of jet → γ flare shape, $\lambda\lambda\lambda$ correlations
- particle dynamics → flux / spectra variability

...

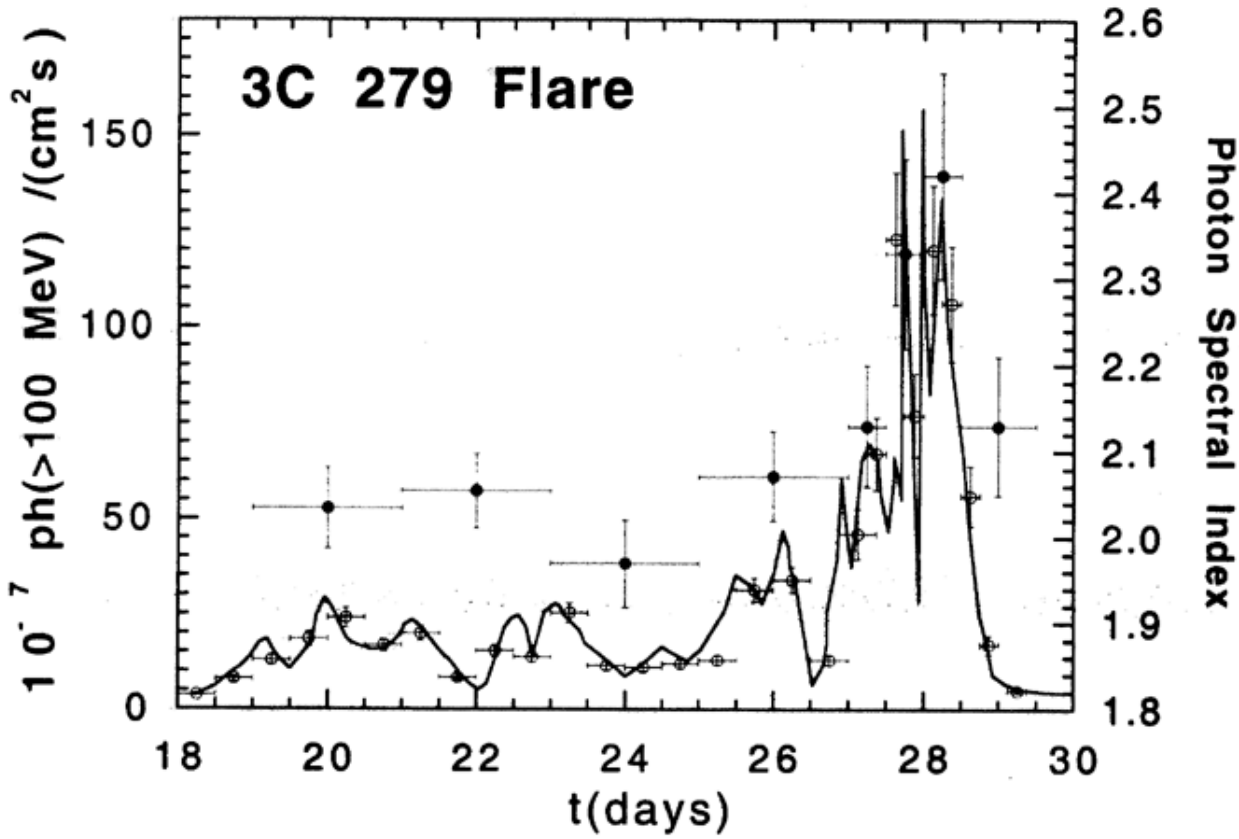
RMS

3C 279 1991 June, flare state (period P1)



Hartman + 2000

RHS


3C 279 Flare
10^{-7} ph(>100 MeV) /(cm^{2}s)
150
100
50
0
18
20
22
24
26
28
30
t(days)
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
Photon Spectral Index

(C. Dermer)

RMS

Cover as many blazars as possible

- new behaviors
- calibrate $\frac{L_{IC}}{L_S}$, $\frac{\nu_{IC}}{\nu_S}$
- duty cycle of γ → are all blazars γ emitters?

Large FOV

⇒ many sources "for free"

GLAST obs triggered by other λ

OPT	RED BL.
X	BLUE BL.

RMS

GLAST as a trigger for ToO ?

<u>Depends:</u>

- how fast info transmitted to ground
- how often
- how quick the "quick look" is
- the type / duration of flares

$t_\gamma \sim 1\,d$

$\sim$ few hrs

(less ?)

RMS

"safest" approach

plan λλλ coverage

<u>at least</u> in critical

bands

... don't discard

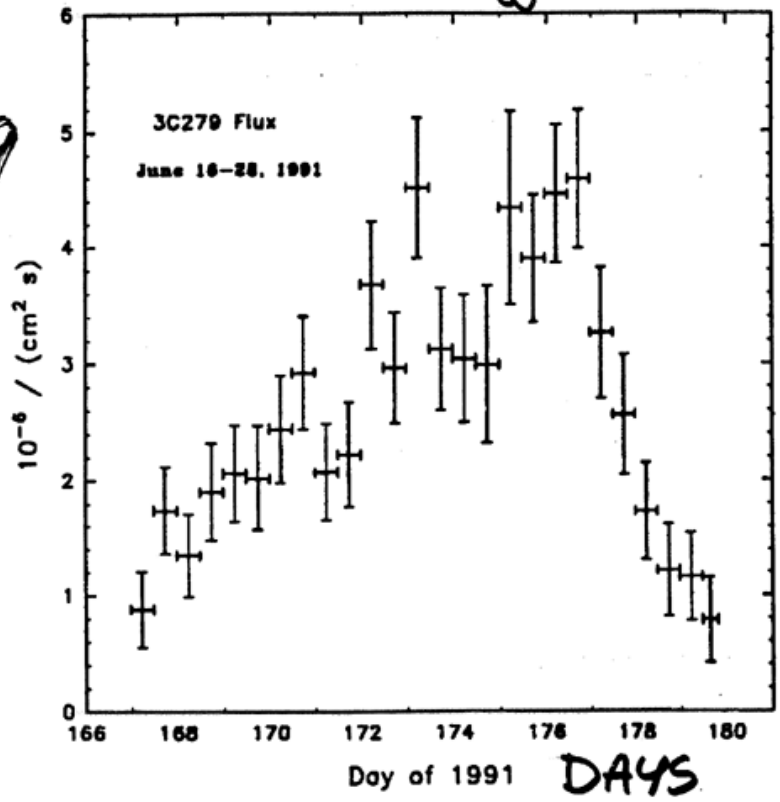
upper limits!

RMS

Knuffen et al. 1993

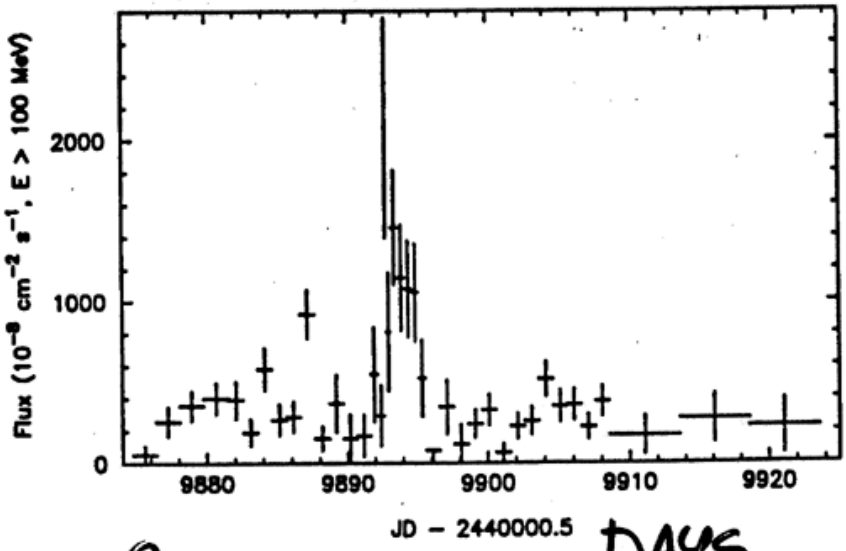
3C 279

$t_\gamma \sim 1$ d



PKS 1622-297

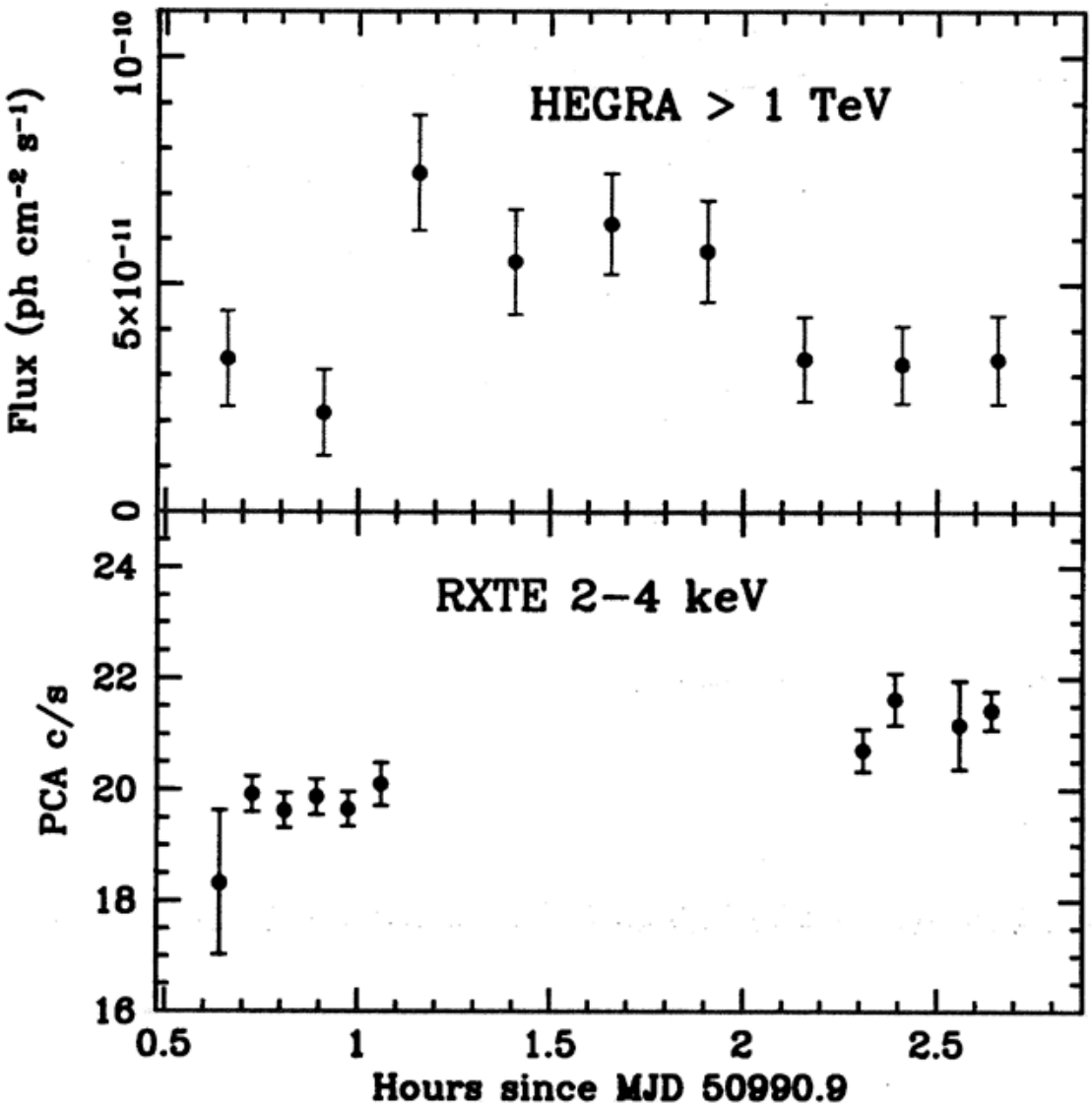
Mattox et al. 1997



$t_d \sim 3.8$ Ros

Sub-hour TeV variability in 1ES1

RHS



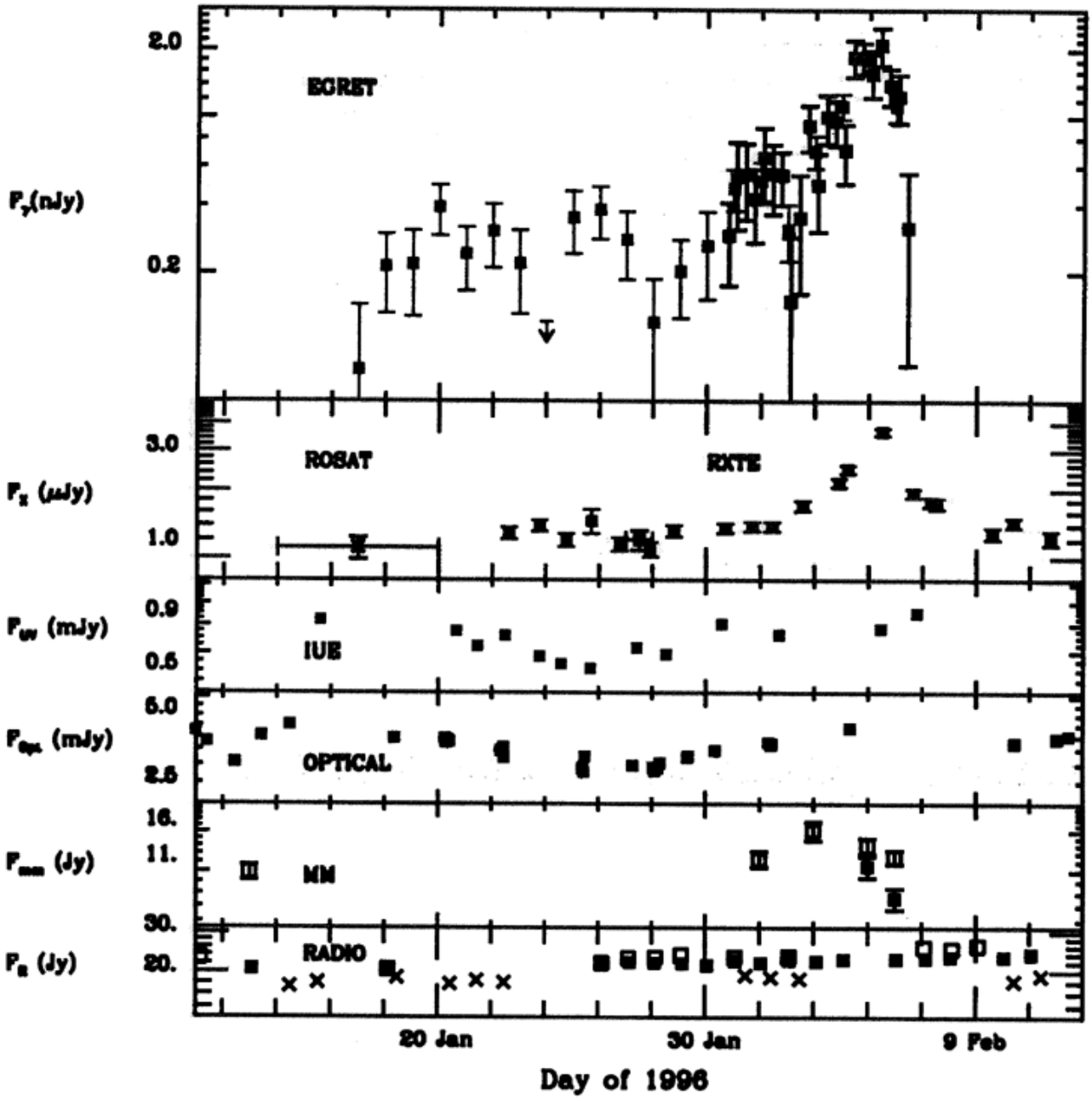
$t_d \sim 20$ min

$R \lesssim 10^{16}$ cm

R. Sambruna +

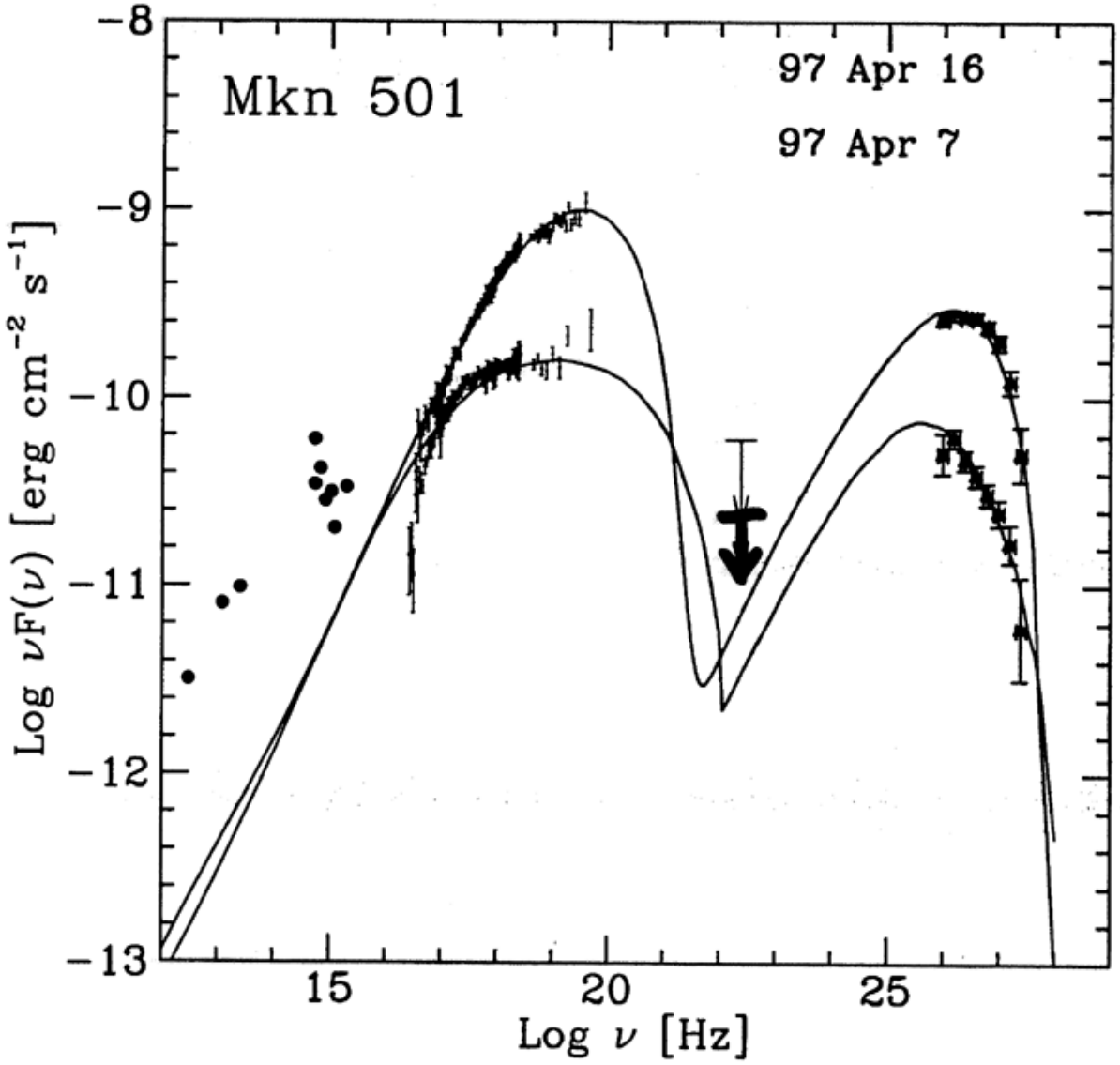
RMS

3C 279 1996 Jan



Wehrle + 1998

RHS



Upper limits are useful!

RMS

λλλ coverage for GLAST

- ground based
  * network
  * involve amateur astronomers (e.g. BL Lac) and smaller Universities (e.g. Foggy Bottom, Crete, Torino, Perugia ...)

- UV missing!
  XRONOS

- Xrays getting problematic
  RXTE, SAX ?
  AstroE2
  XRONOS

[illegible] !

RMS

~ 5,000 AGN detected by GLAST

➡ statistical samples
luminosity trends
luminosity function

BUT

need counterpart first!

GLAST error box : ~ 6'

Chandra : ~ 0.16 $\frac{\text{sources}}{\text{arcmin}^2}$

F_X (2 - 8 keV) ~ 4×10^{-15} erg/cm²/s

S3, 44 KS

(Brandt + 2000)

➡ ~ 6 sources in 6' x 6'

RMS

Need cross-correlations

X rays

optical

radio

dedicated telescopes?

enough workforce

RMS

The unknown:

GLAST potential for new discoveries

AGN

- **Radio galaxies**
  - beaming
  - SSC vs. EC

Cen A — Nolan + 96, Hartman + 99

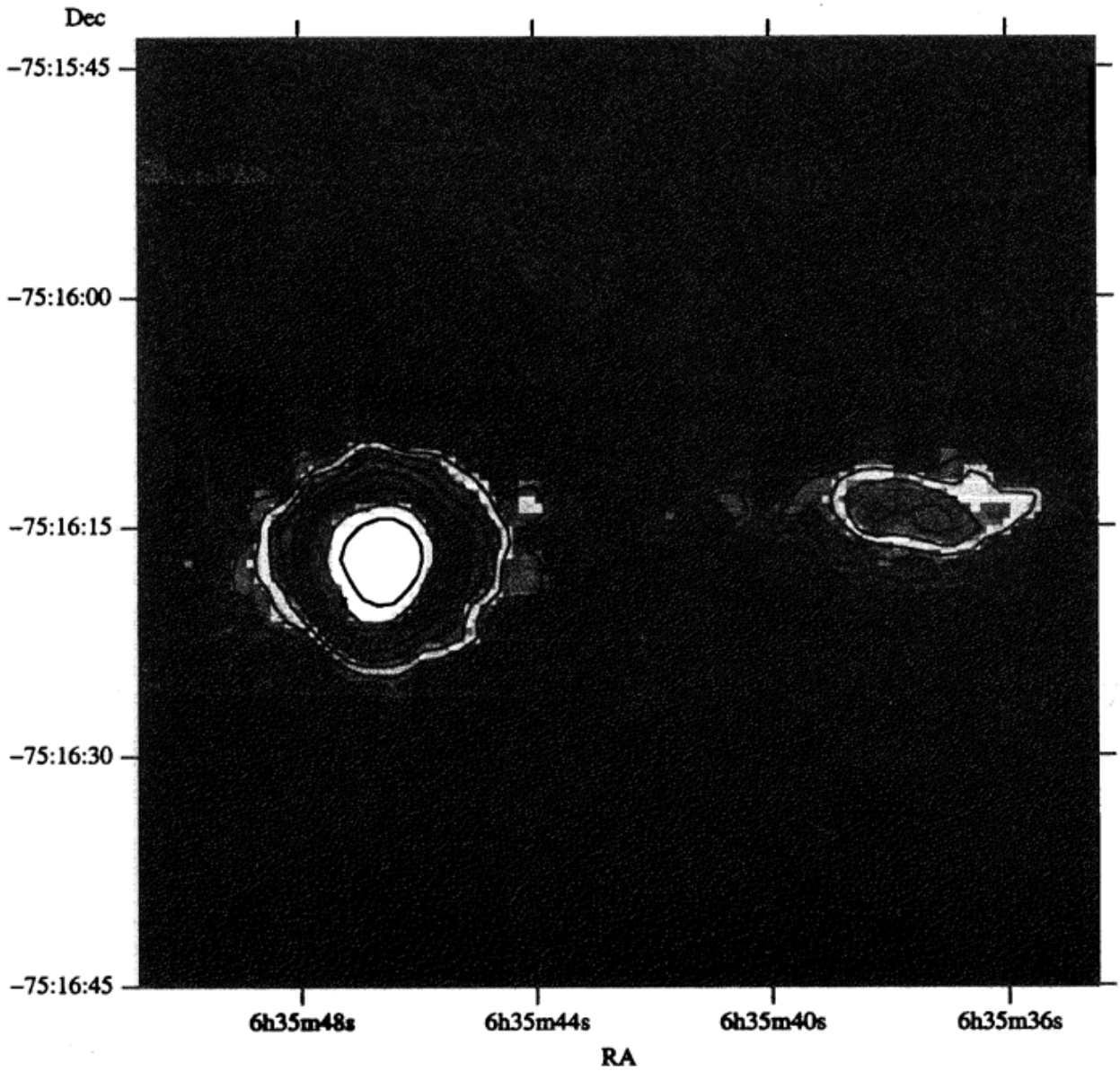
M87, Pic A, ...

Extended jets (e.g. PKS 0637, 3C 273 ...)

RHS

PKS 0637 − 752 (z = 0.654)

Chandra 100 ks

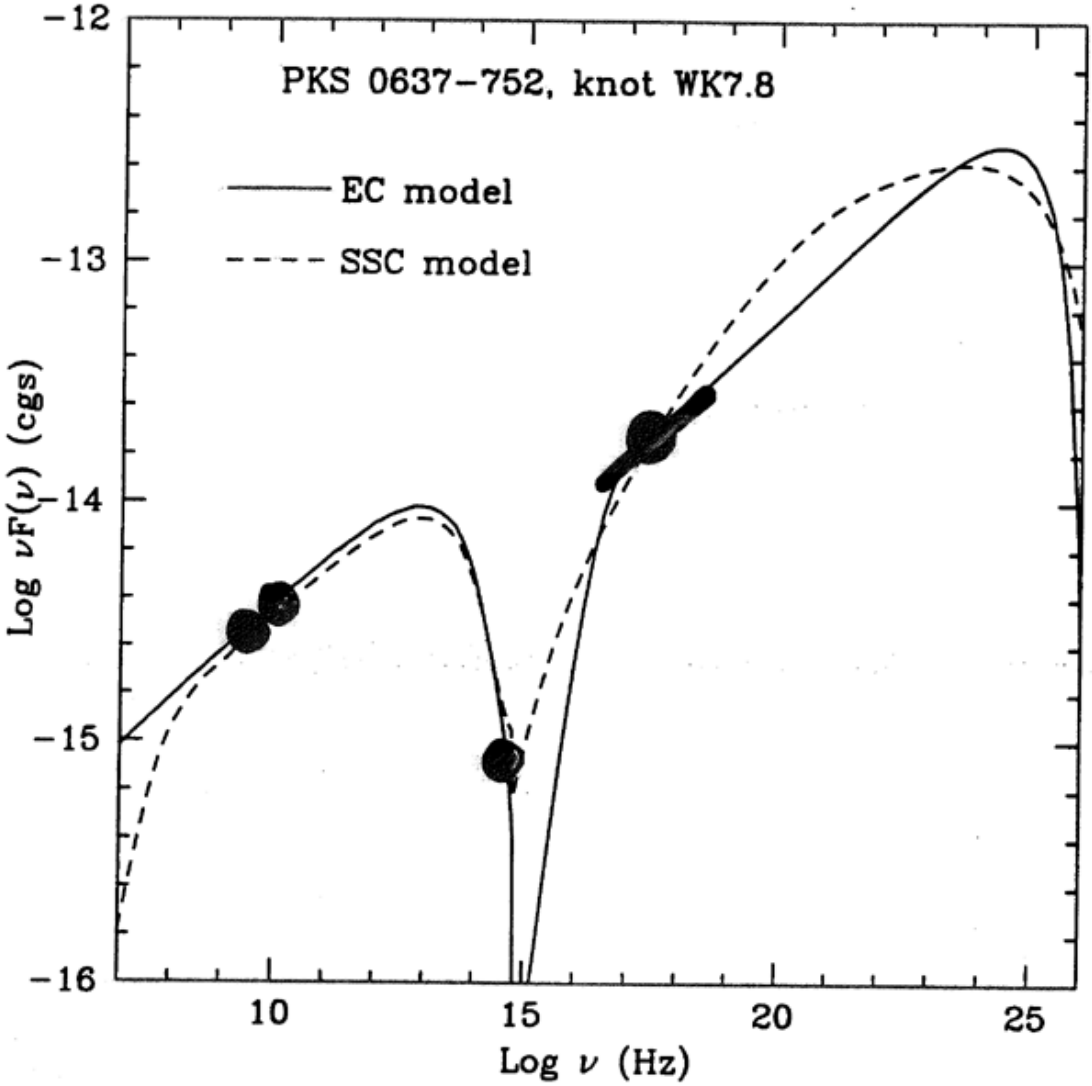


Chartas + 2000

RMS

PKS 0637-752

SED knot WK7.8



Schwartz et al. 2000
Tavecchio et al. 2000

- Seyferts, LLAGNs, LINERS... RHS

  compact radio cores,

  SL, jets

  Falcke + 2000

  Brunthaler + 2000

  Nagar + 2000

origin of radio-loud / radio-quiet AGN ?