The spectral sequence of blazars : present status and expectations from GLAST

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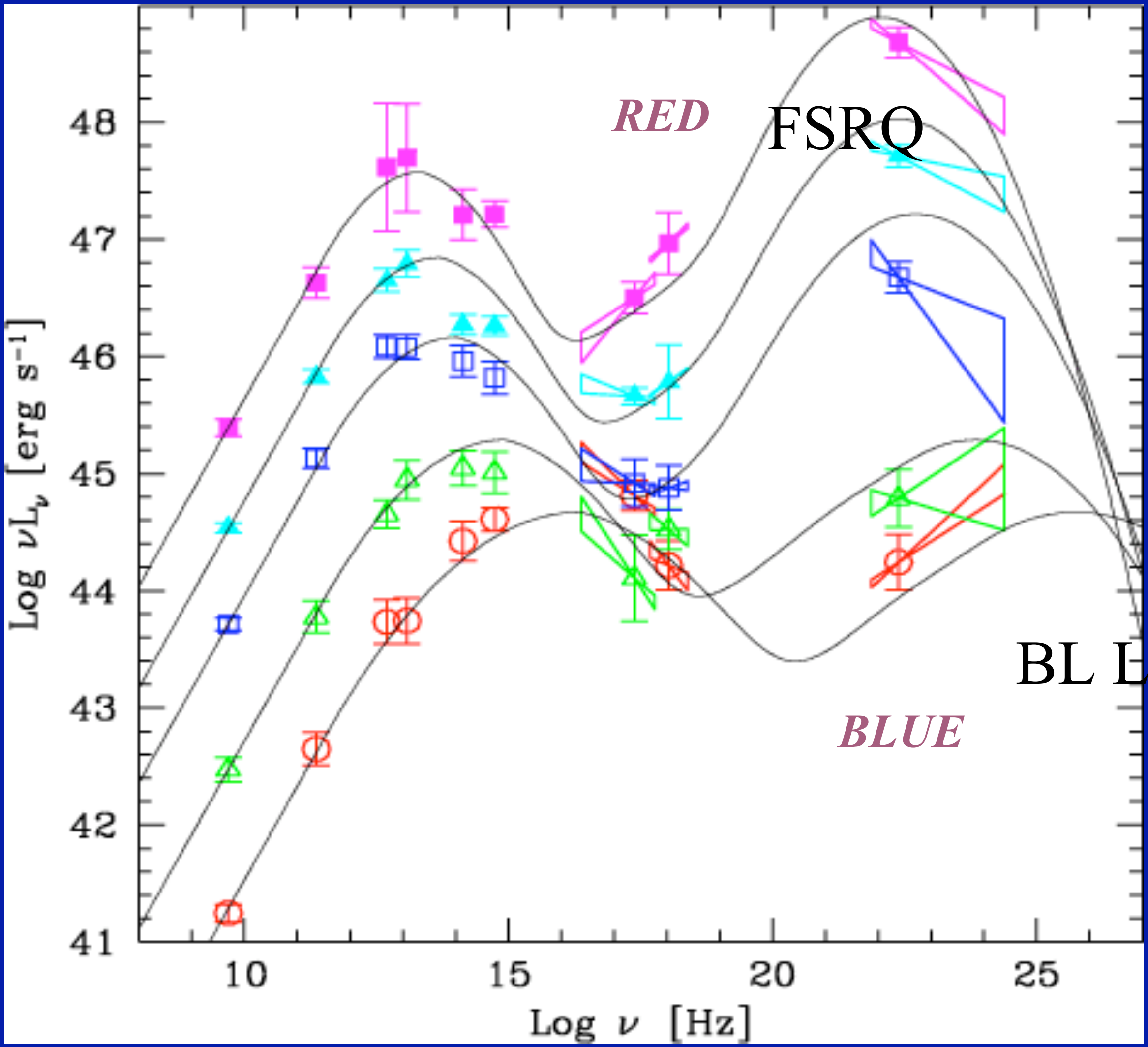
The Blazar Spectral Sequence

Fossati et al. 1998; Donato et al. 2001



Average spectral energy distributions of blazars:

a systematic dependence on jet luminosity ?

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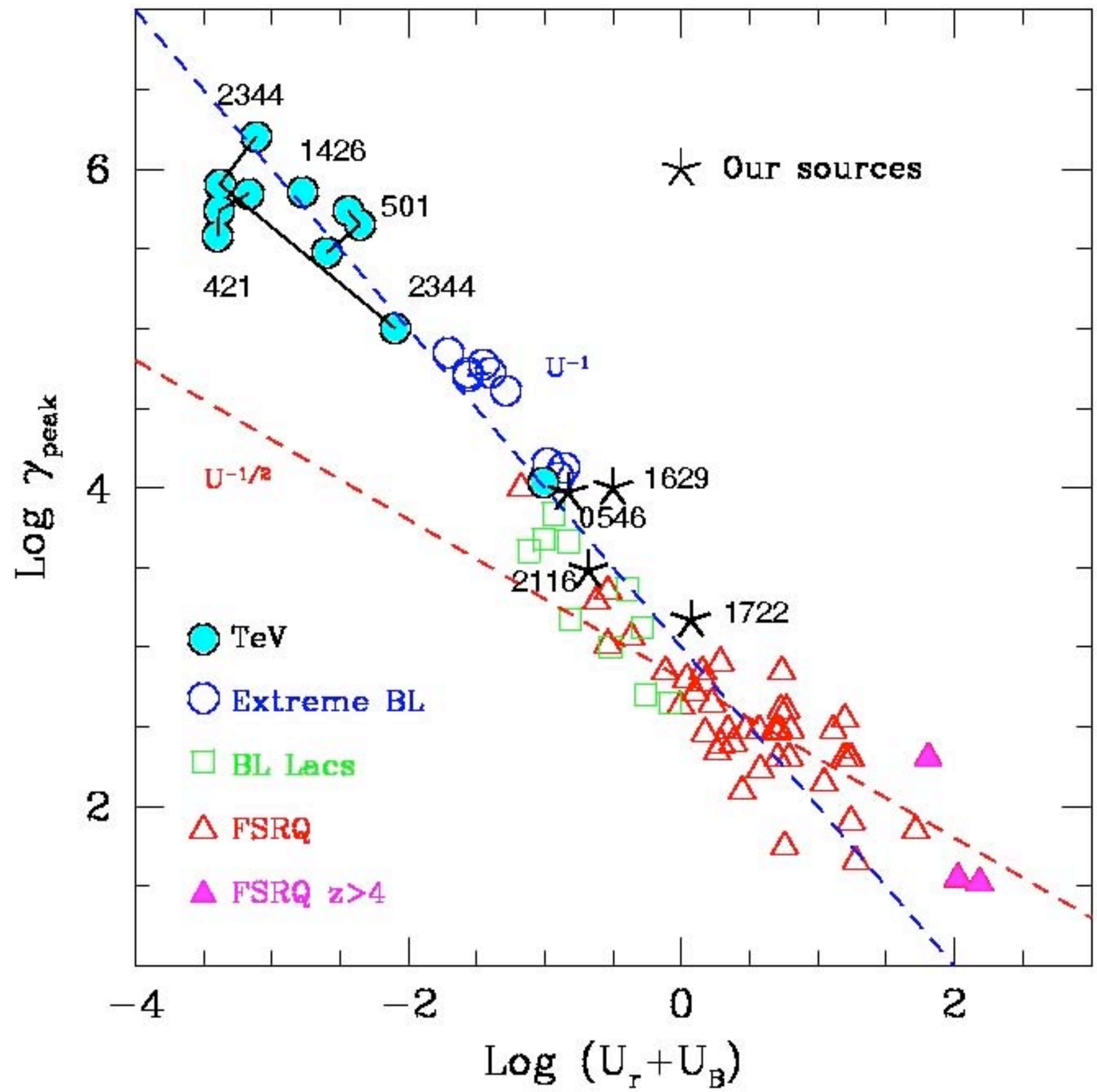
Construction Method

- Three different complete samples: 2Jy FSRQs, 1Jy BLLacs, EINSTEIN Slew Survey BL Lacs
- Sources binned in radio luminosity irrespective of original sample
- Averages of monochromatic luminosities within each bin

Theoretical modeling of individual sources shows that the sequence corresponds to a systematic change of the the model parameters Ghisellini et al. 1998……….



Jet - accretion flow connection

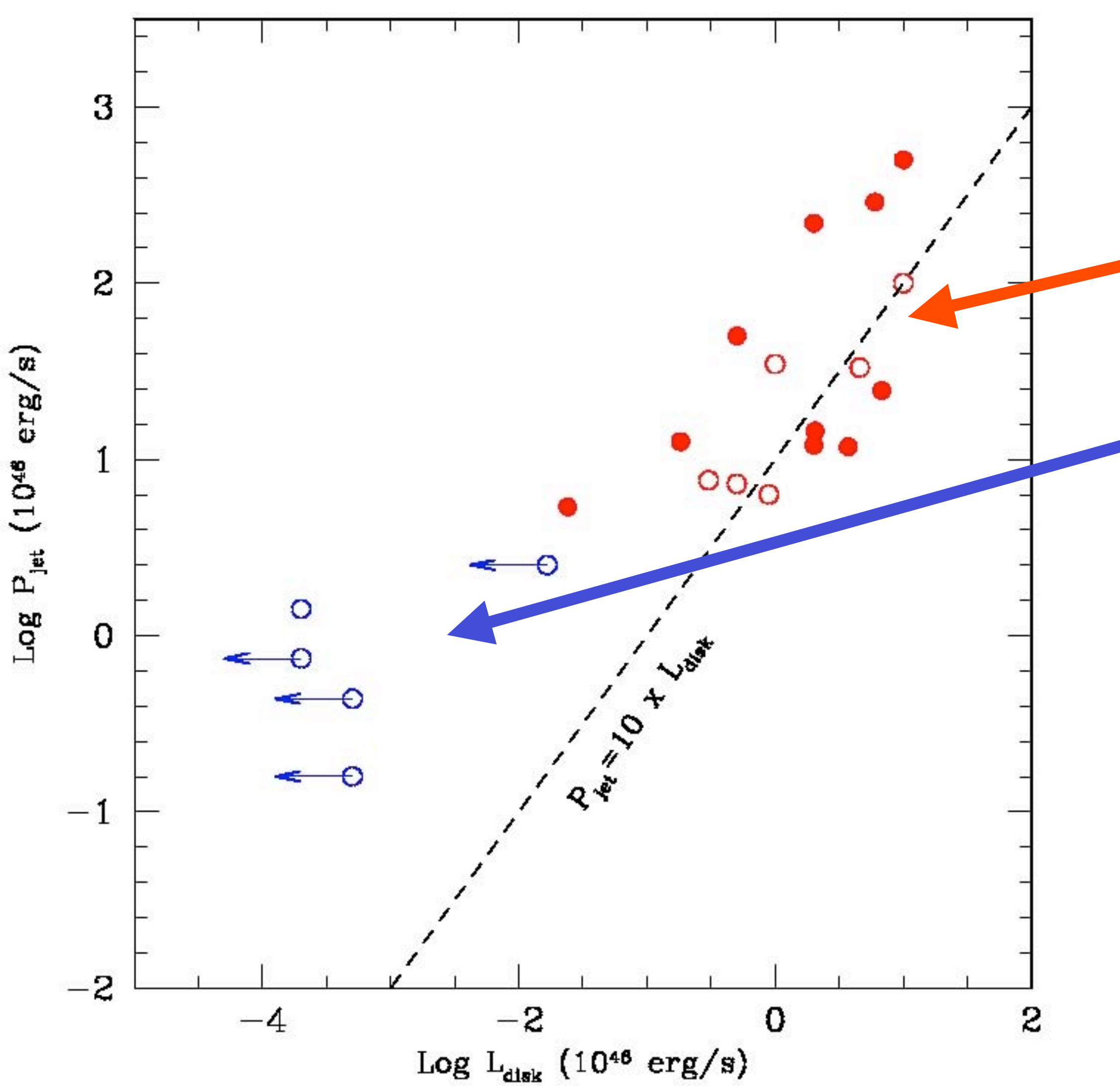
From observations we can estimate the luminosity (or u.l.) of the accretion disk.

Modelling SEDs with good data coverage (gamma important) the jet power can be estimated.

Comparing the two involves the radiative efficiency of the accretion flow ~ 10%, for a standard disk

Jet power vs. accretion power

From SEDs of objects with sufficient data



At high P (FSRQ)
$P_{jet} = Pacc_{disk}$

At low P (BL Lac)
$P_{jet} > L_{disk}$
If $P_{jet} \sim P_{disk}$

$\Rightarrow \varepsilon < 0.01$

Maraschi 2001
Maraschi & Tavecchio, 2003
Sambruna et al.2006,

The blazar sequence can be understood as a sequence in $\dot{m}$

(Accretion rate in Eddington units)

- High accretion rates produce bright disks and powerful jets
- Low accretion rates explain the absence of optical signatures of disks by radiatively inefficient accretion (ADAF) in less powerful jets
- The sequence can be related to cosmological evolution of black hole masses (increasing with time) and accretion rates (decreasing with time) leading to an overall decrease of $\dot{m}$

Maraschi 2001; Boettcher & Dermer 2002; Cavaliere & D' Elia 2002; Maraschi & Tavecchio 2003;

For these possible profound implications it is important to test and extend with

GLAST

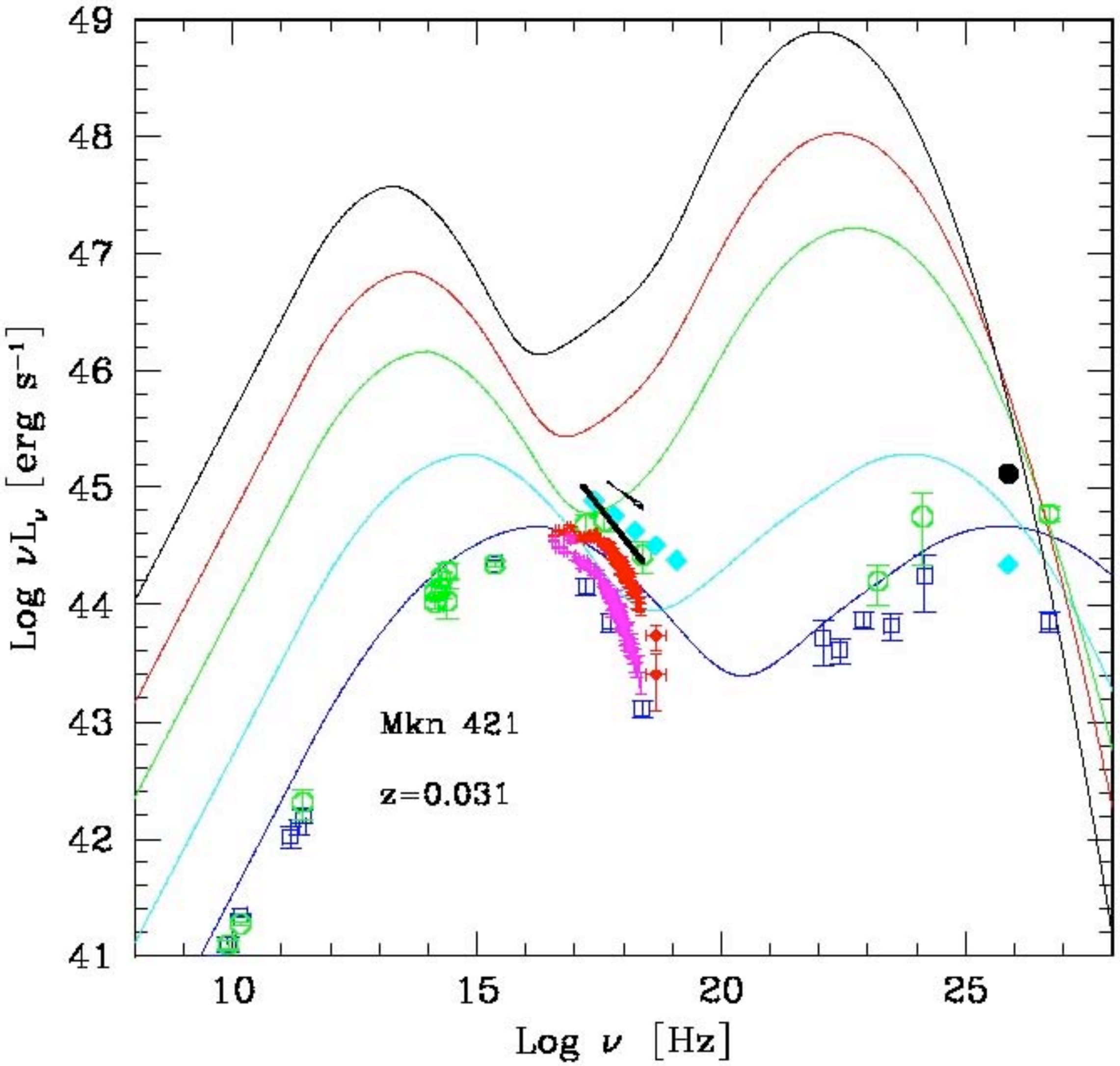
the original blazar spectral sequence

-- complete the gamma-ray coverage of the old samples … remove flaring bias at least for bright objects

-- search for gamma-ray emission for other samples (a gamma-ray selected sample?)

MKN 421

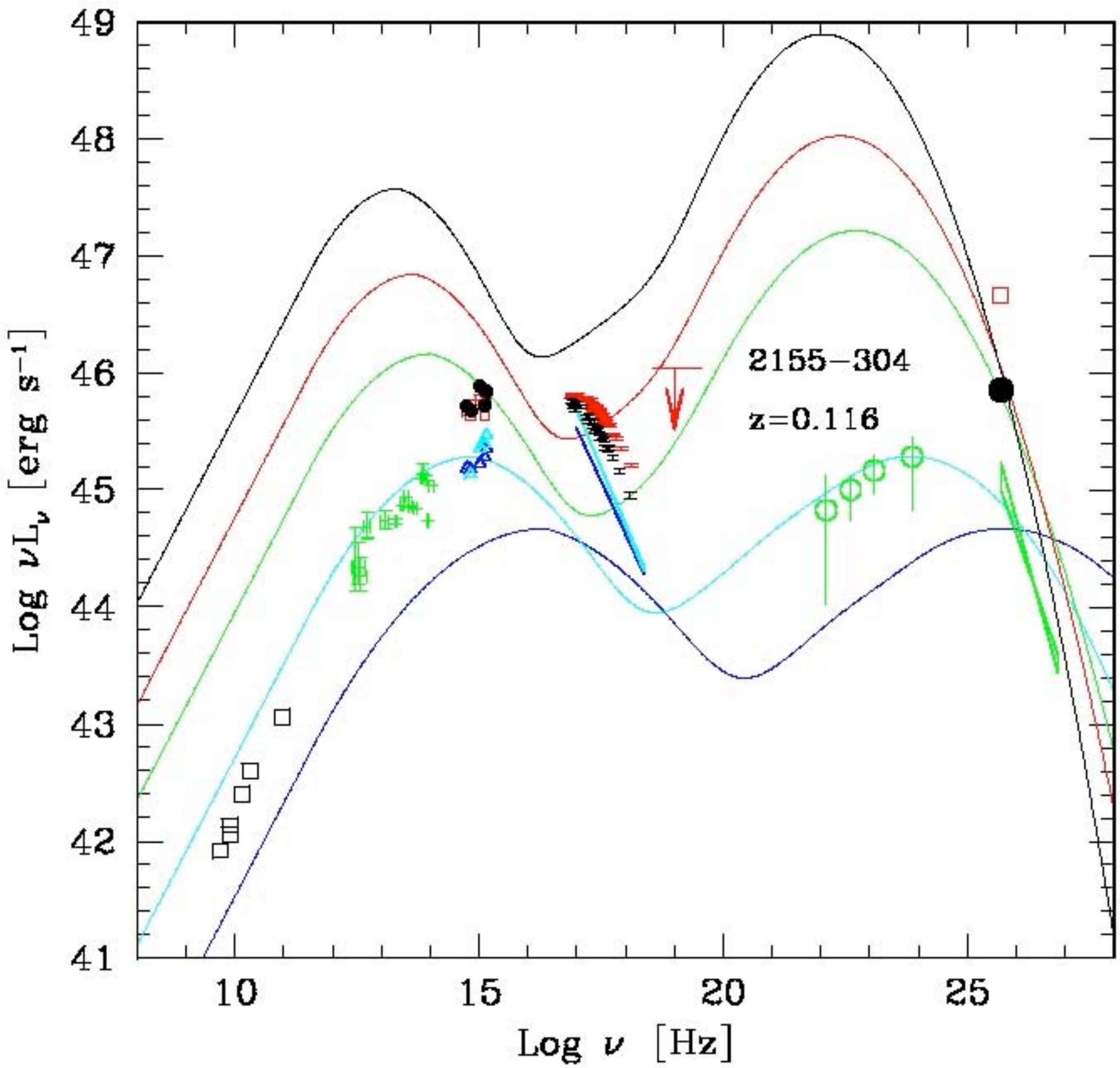
A collection of X-ray and gamma-ray states:
An obedient source



PKS 2155

An HBL of extreme luminosity;

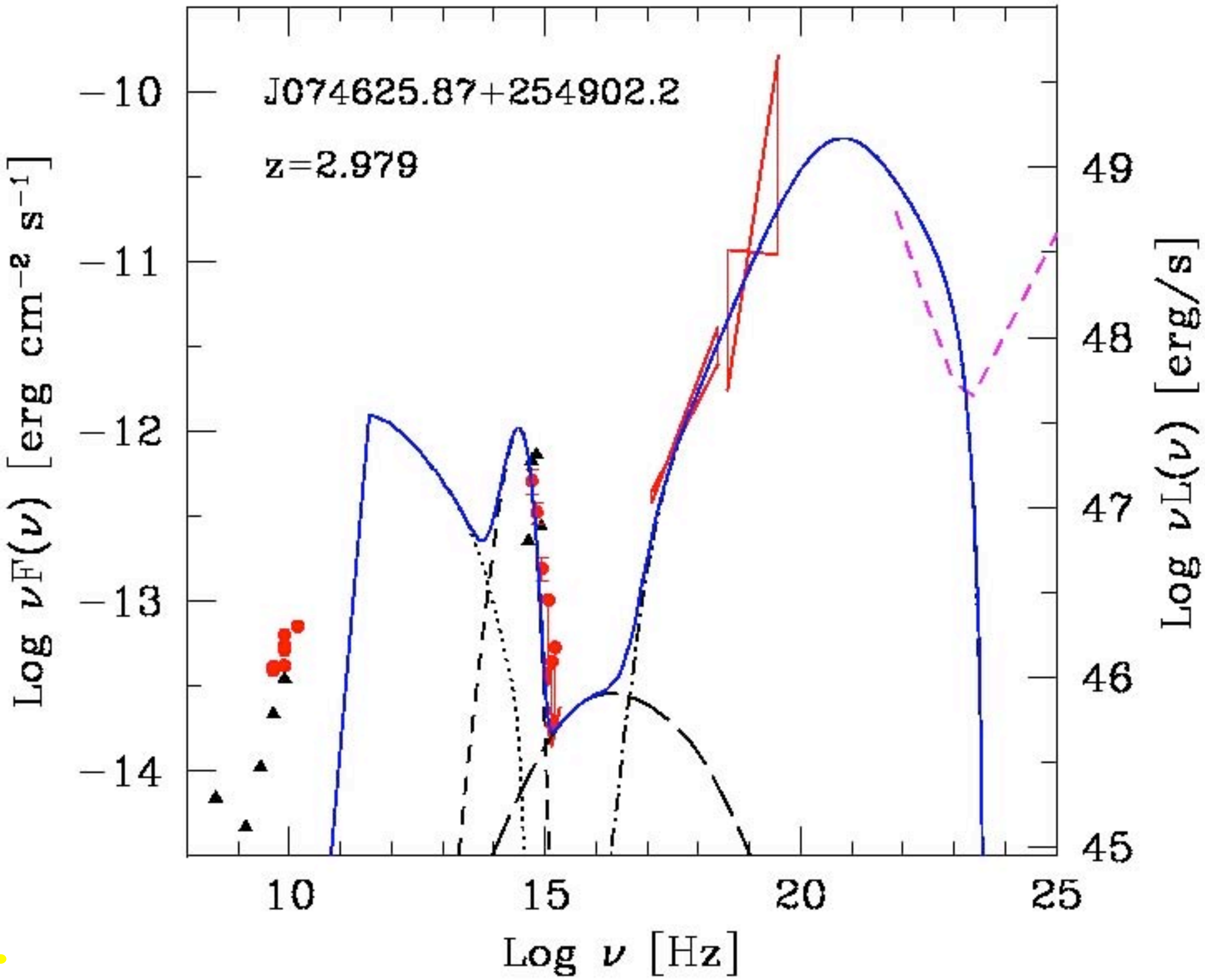
Jul 06 flare
Foschini et al.
(see Poster)



A high redshift extremely luminous FSRQ discovered with BAT (SWIFT)

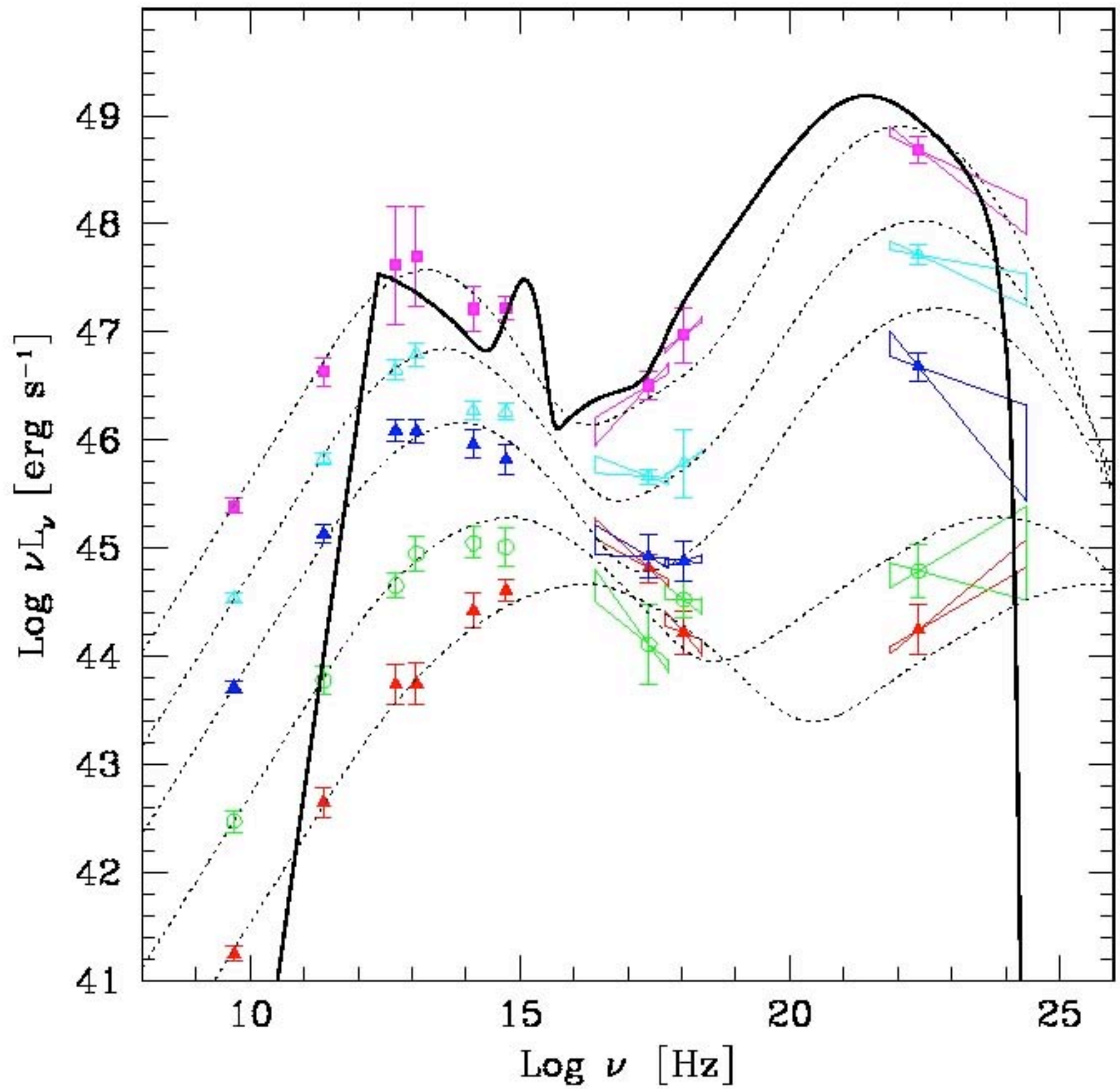
GLAST detection expected

Sambruna et al. 2006



J0746+25

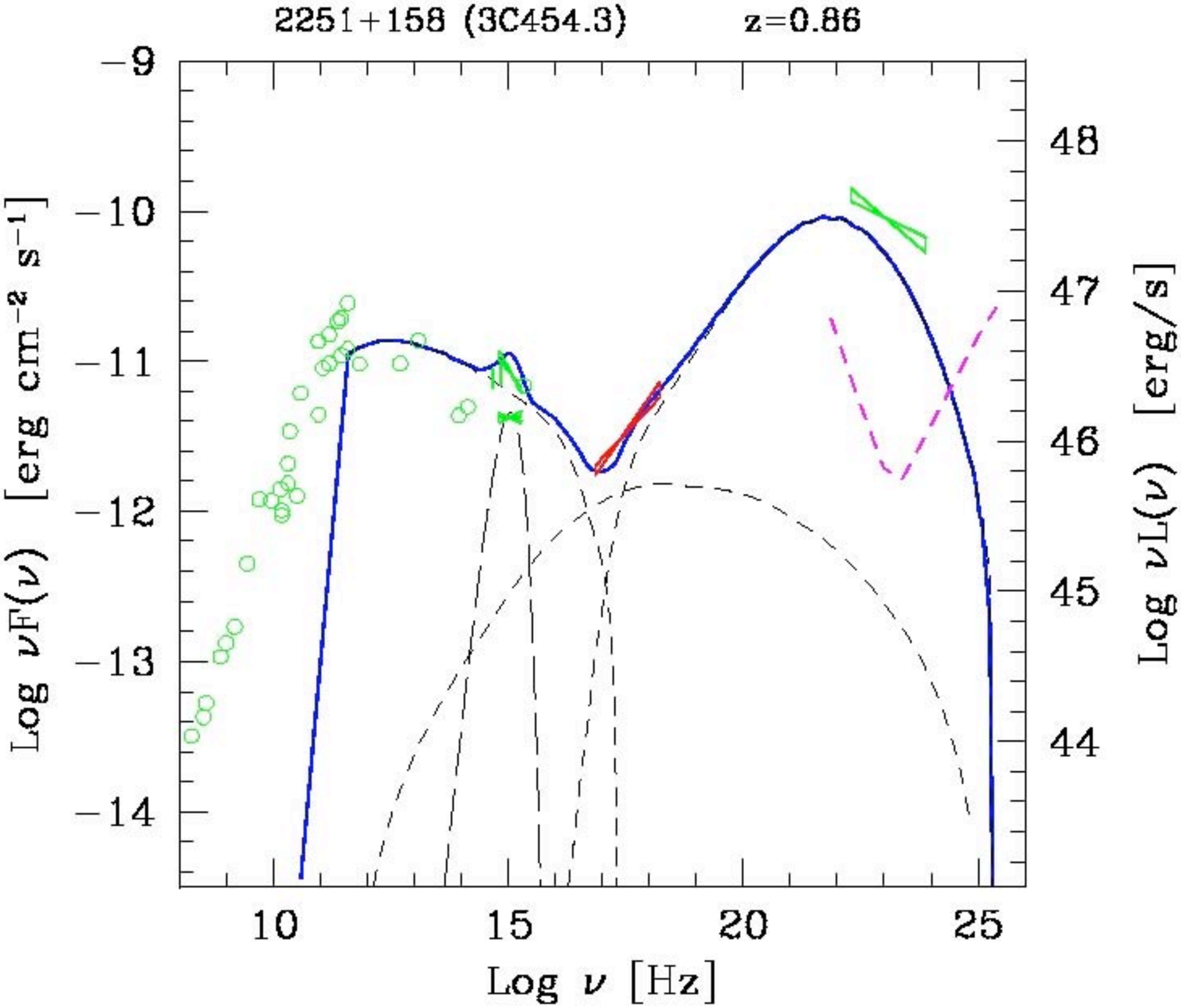
A perfect fit to the sequence



3C 454.3
A less extreme Gamma-ray Blazar from EGRET

An extended X-ray jet discovered with CHANDRA

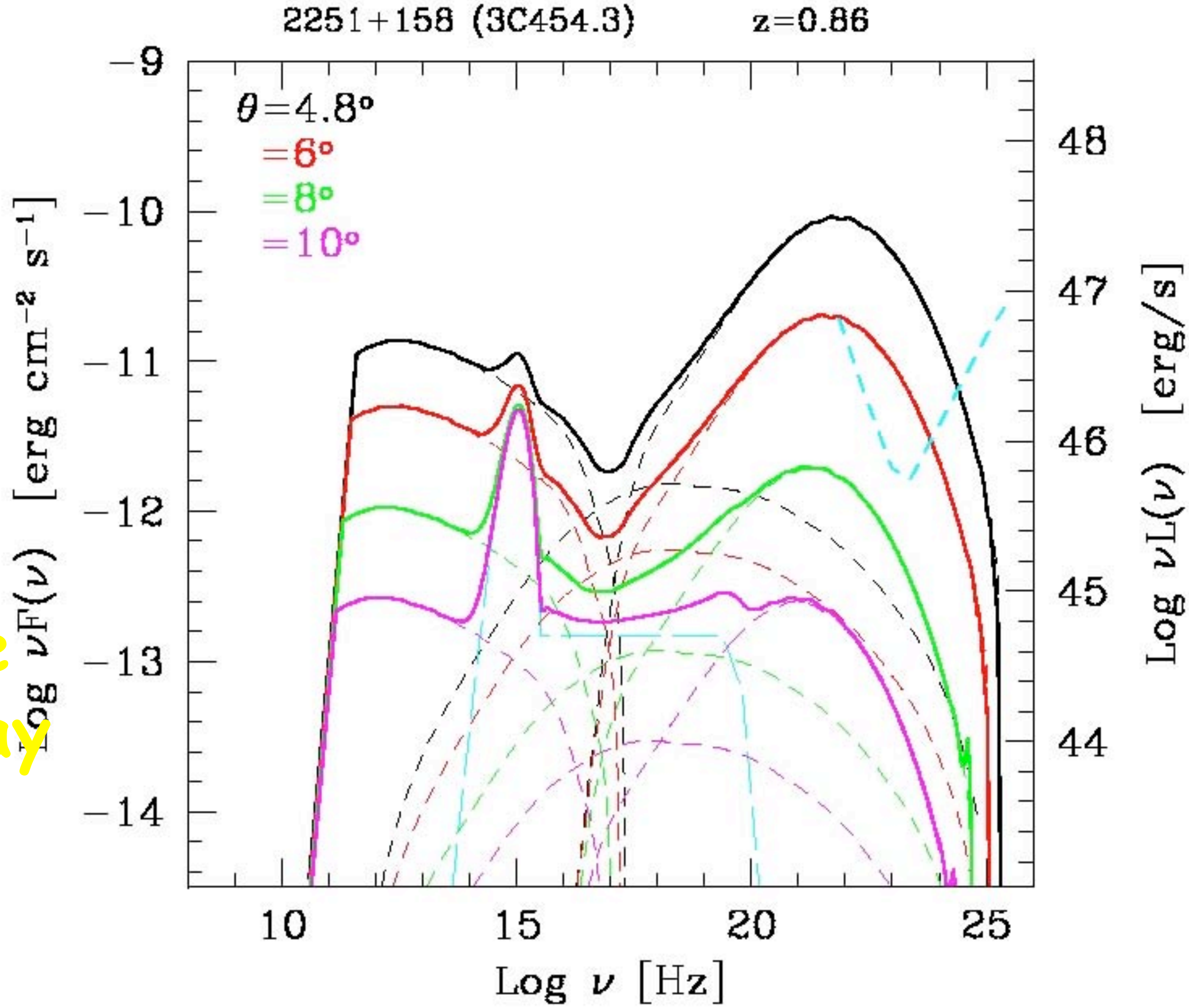
Tavecchio et al 2007



Changing the angle of view

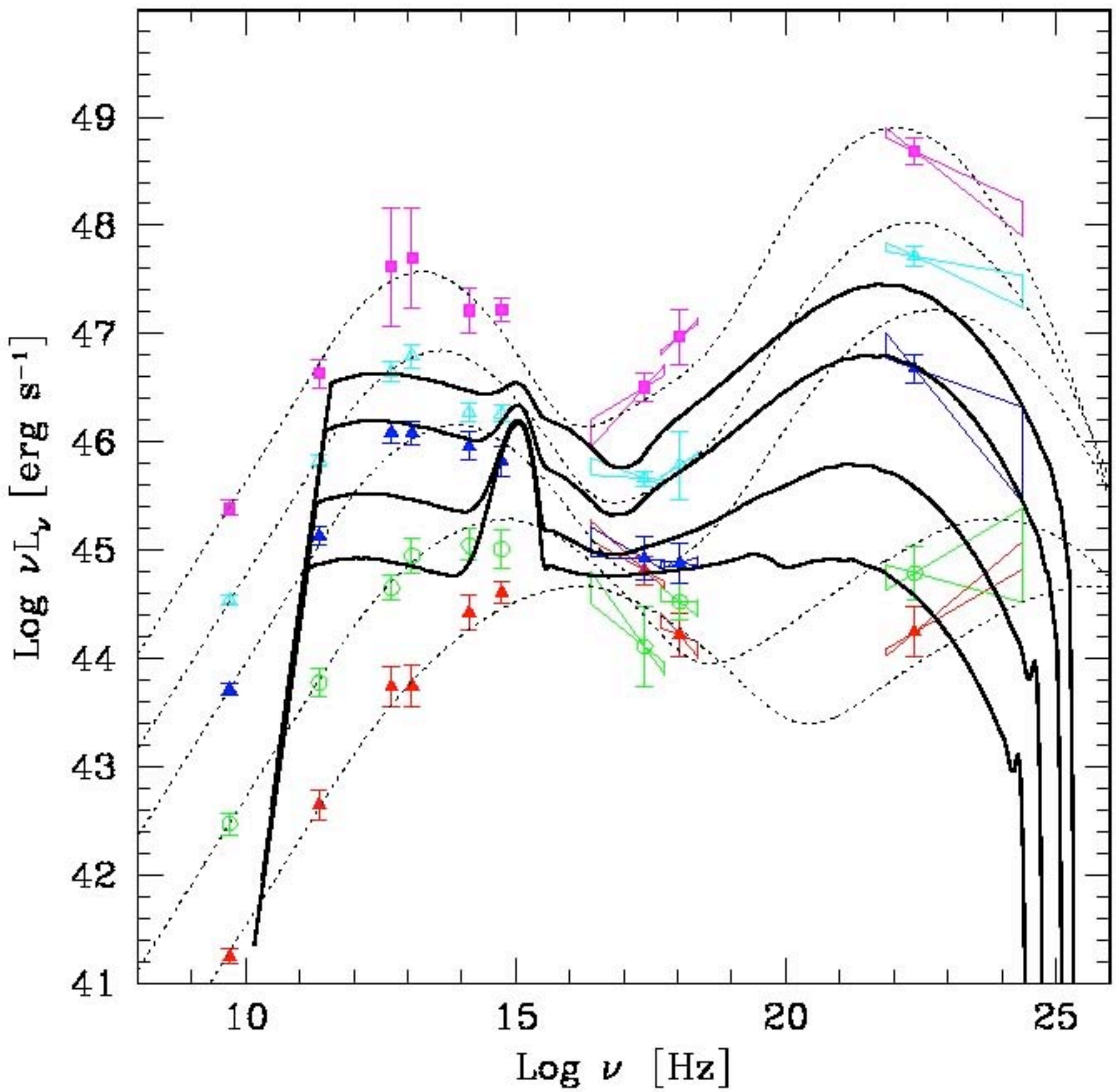
Observable with GLAST also at larger angles

Note the change in the gamma-ray to blue bump ratio



Effect of the viewing angle within the sequence

The position of the peaks does not change dramatically.
The blue bump retains its high luminosity



Disentangling disk and jet in "mixed" Blazar cores

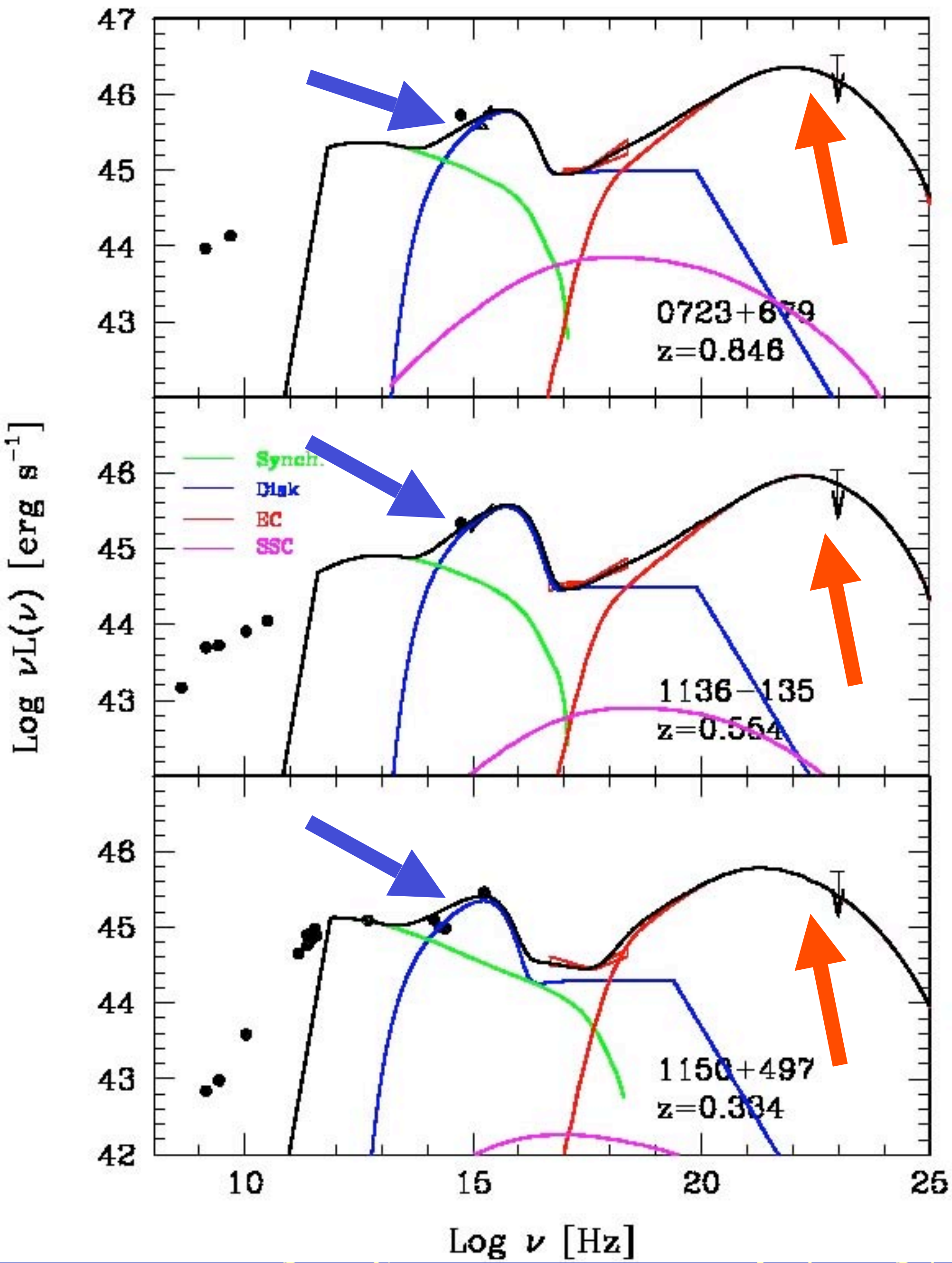
Accretion disk:

Blue Bump and X-ray p.l.

Jet :

Synchrotron and Inverse Compton components

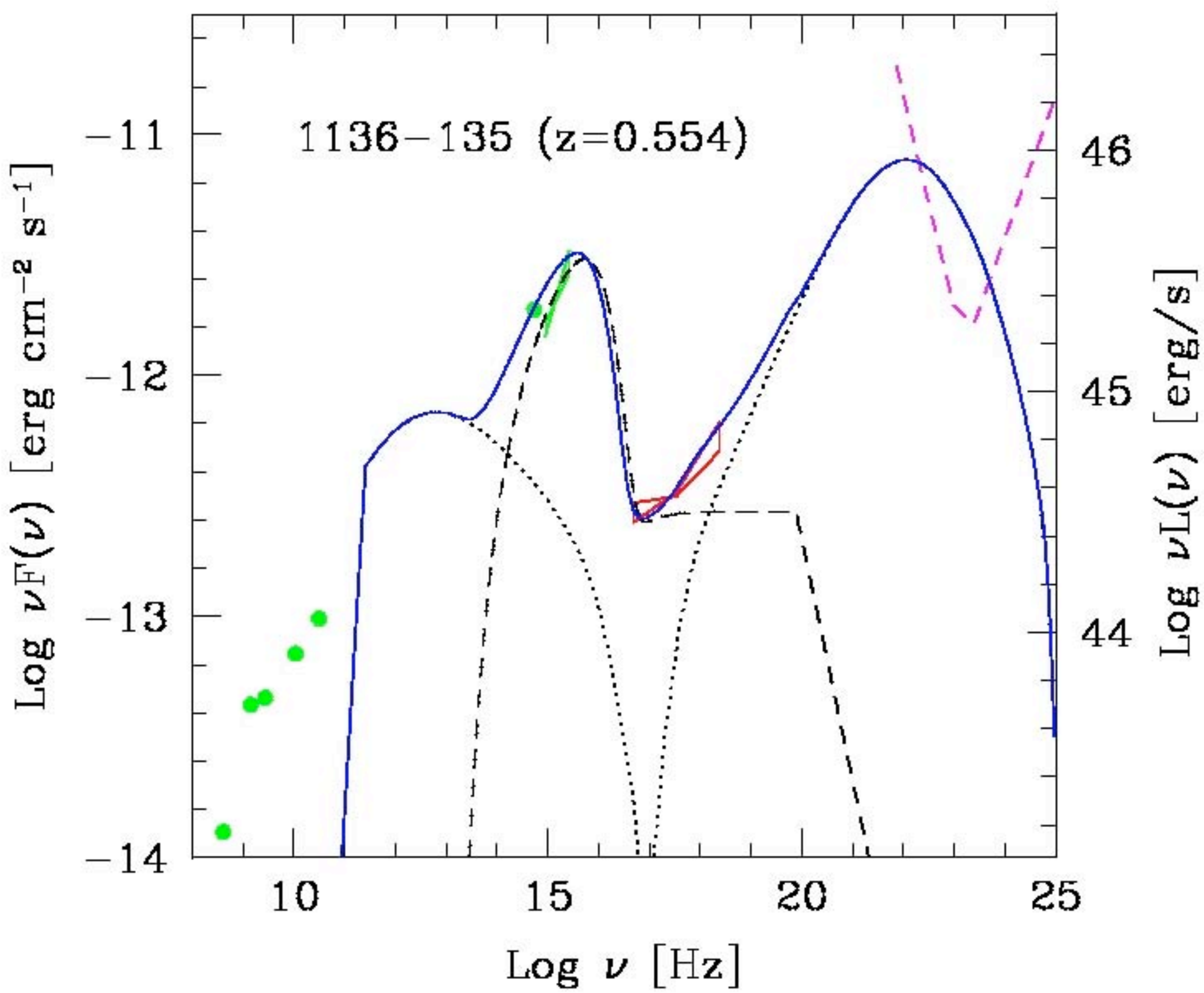
Sambruna et al. 2006



1136-135
FSRQ with extended X-ray jet
EGRET u.l.

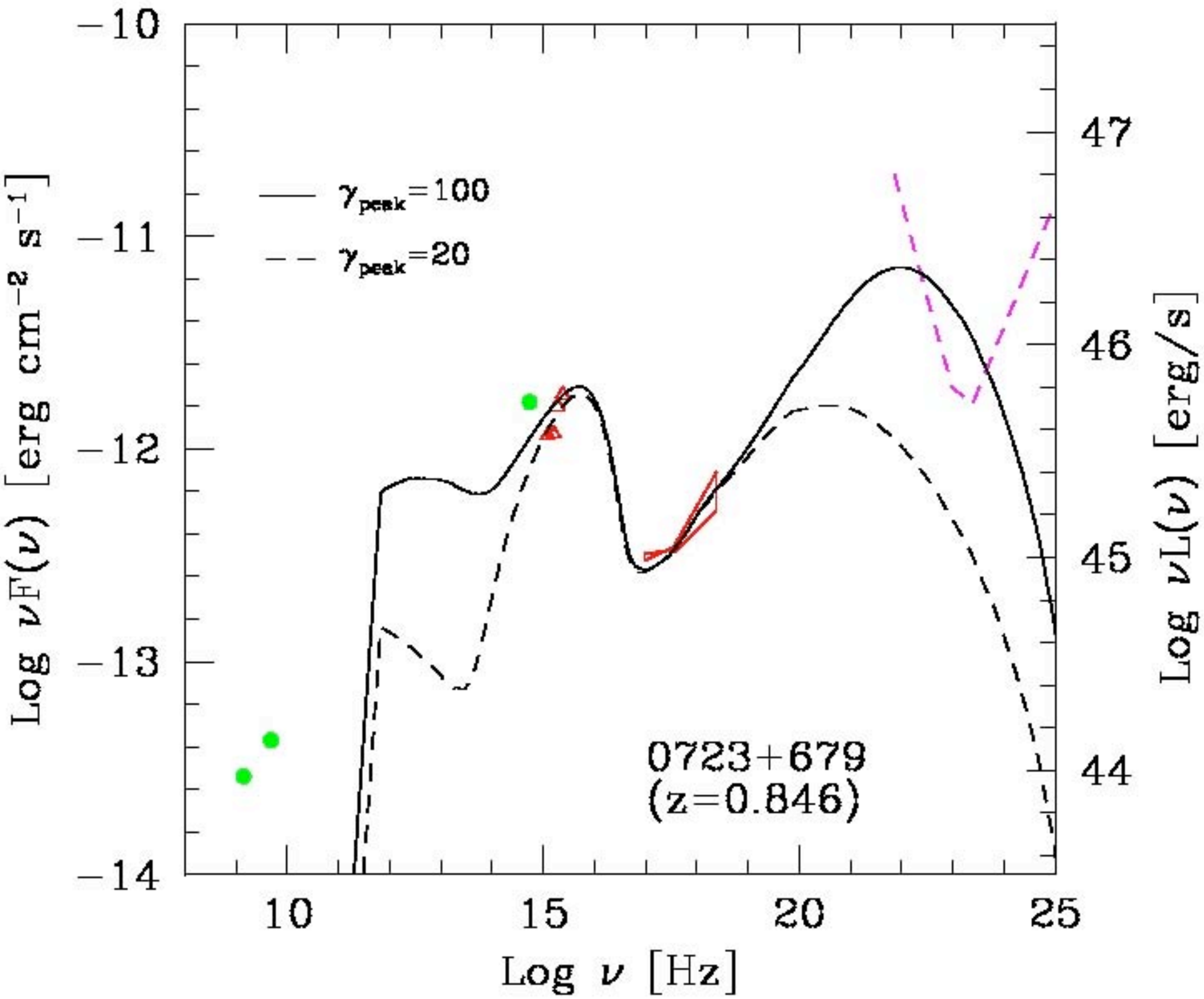
Expect GLAST detection as for 0723+679

Sambruna et al 2006



The effect of a change in gamma peak is illustrated:

The gamma-ray luminosity decreases a lot but the kinetic power carried by the jet is the same

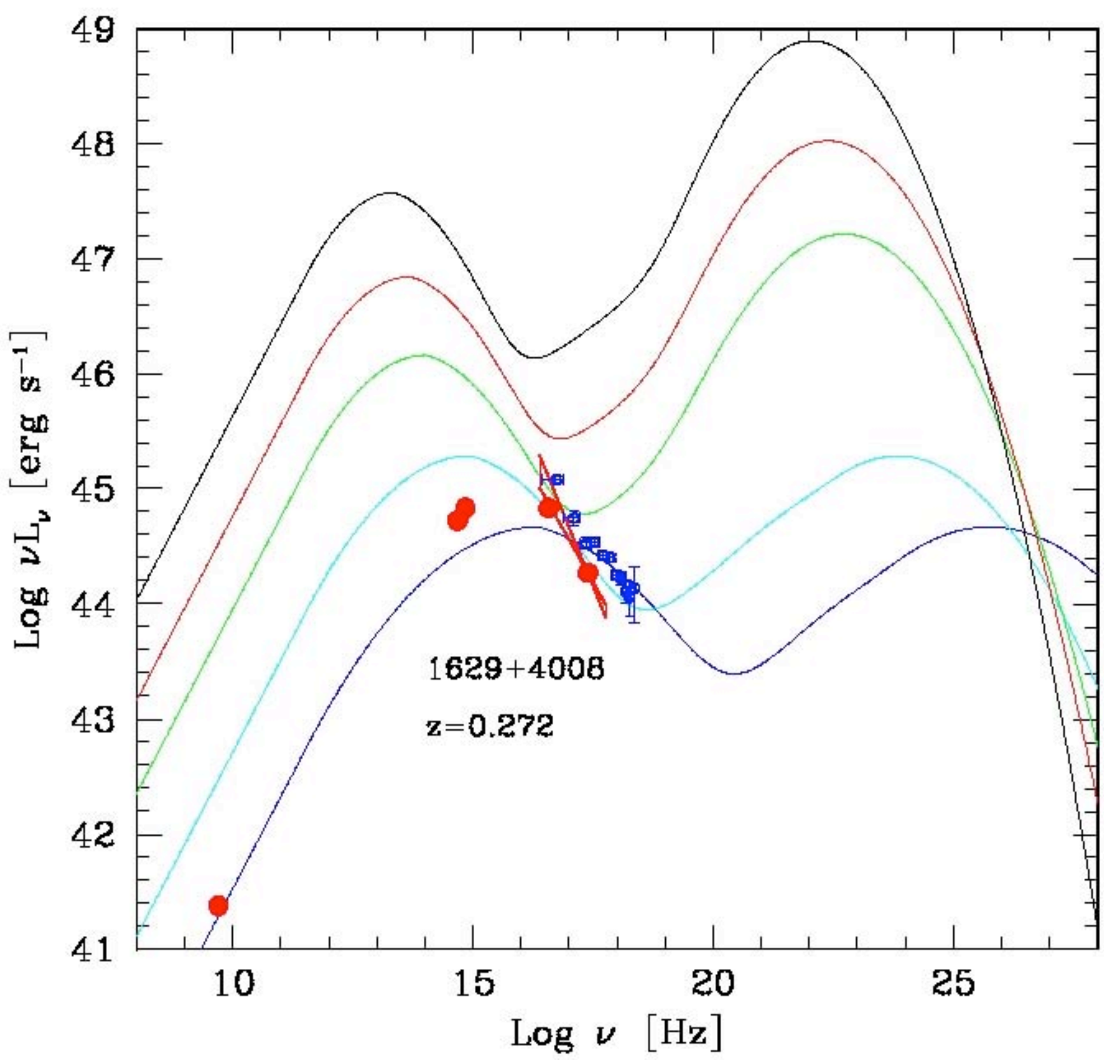


1629+4008
An unusual object:

An HBL with a Seyfert like accretion disk

The jet SED Conforms to the sequence

Padovani et al. 2002



The optical spectrum suggests a Seyfert-like accretion disk
with L = 4 x 10 (44) erg/s

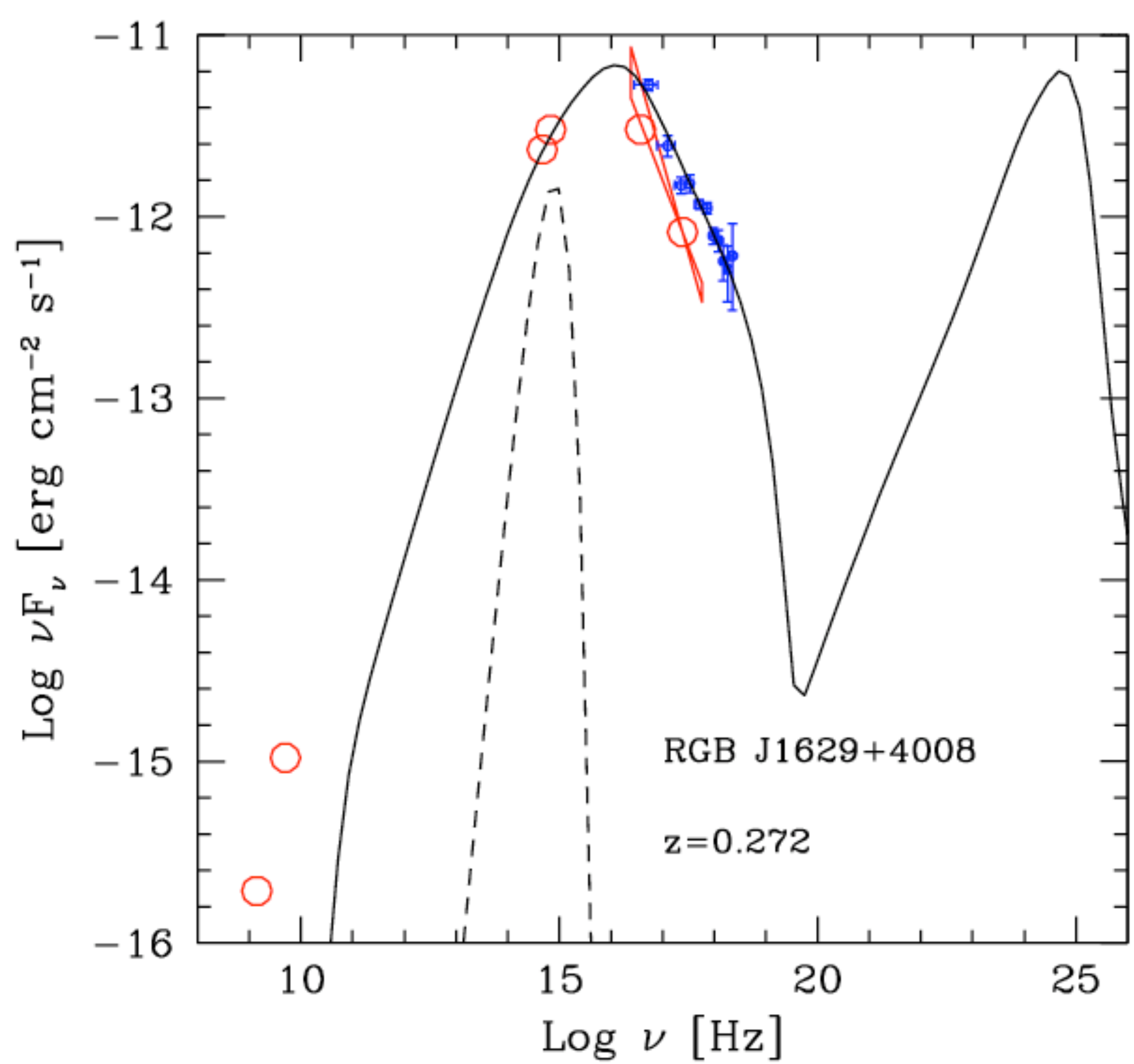
The accreion rate must be above 0.01 Eddington

This object should have relativly low mass10 (7-8) solar masses

Need gamma-ray data to estimate the jet power

Synch.+IC model for 1629 +4008

Gamma-ray component uncertain: here EC, but SSC could fill the hole… GLAST observation needed !



Conclusions

- The unprecedented sensitivity of GLAST will allow to probe
- Jets at intermediate angles and "intrinsically" less powerful jets in intermediate mass objects
- Progress in understanding the jet spectral properties and the jet-disk connection is expected but requires multifrequency coverage