

Relativistically Beamed Jets & the Blazar Divide

Prajval Shastri

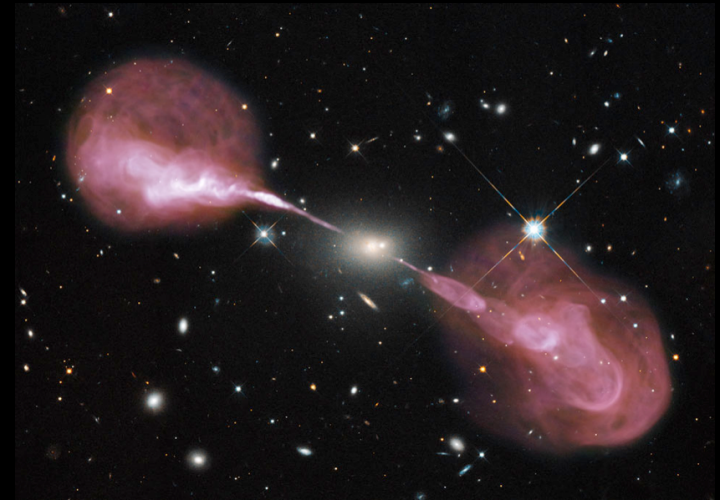
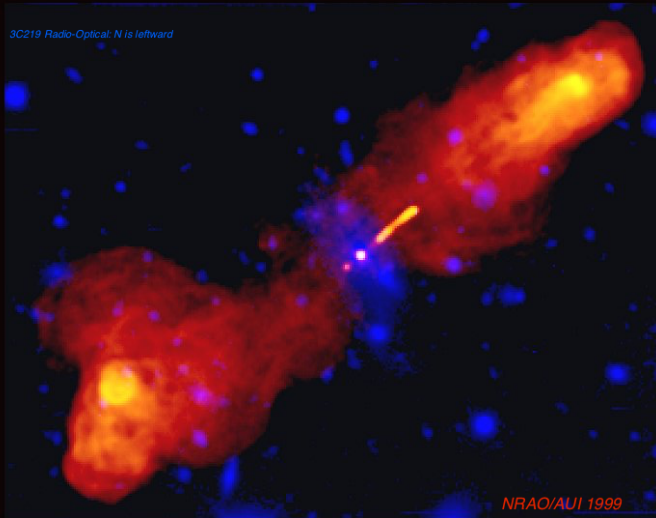
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Maitrayee Gupta

Bindu Rani

Grzegorz Madejski

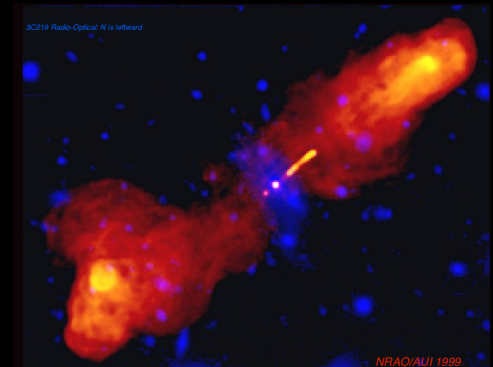
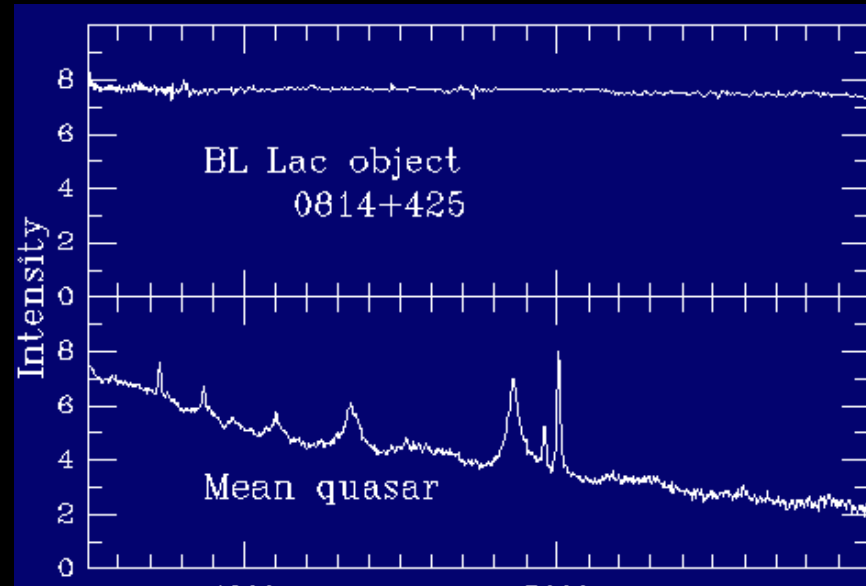
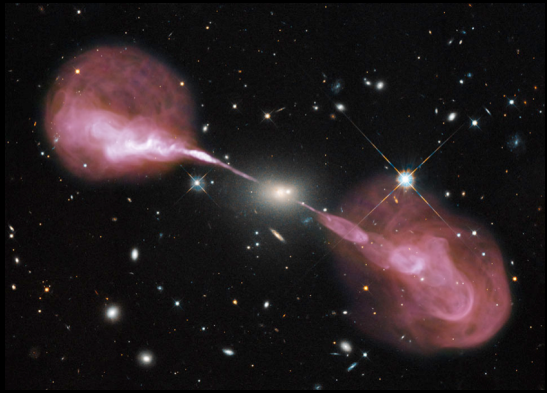
Estrella Jimenez Gomez

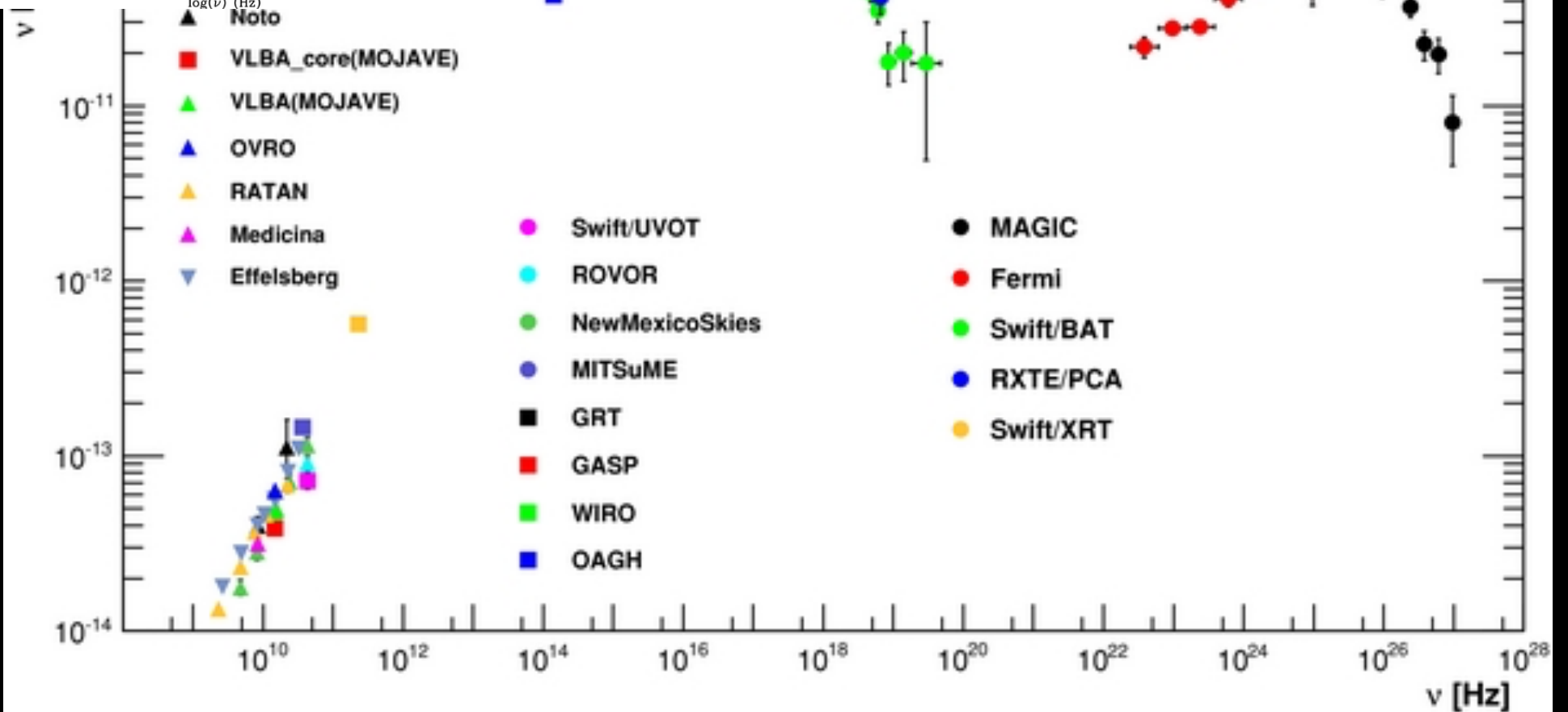
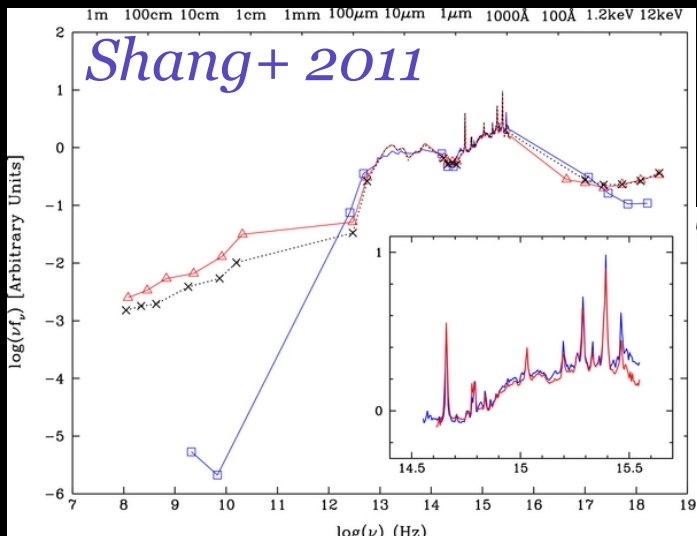


BLAc + quaSAR -> BLAZAR:

The PHENOMENON of AGN emission being:

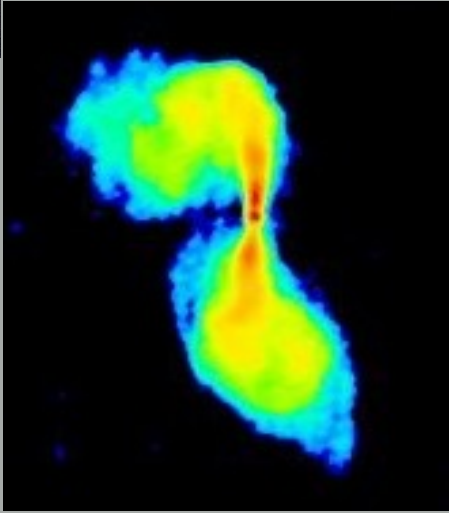
- *dominated by synchrotron (& IC)*
- *highly polarised*
- *highly variable at all wavelengths*
- *high polarisation variability*





old-school Strawperson scheme

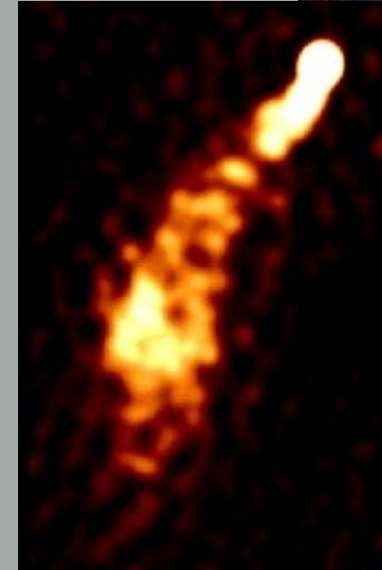
Luminosity



relativistically beamed



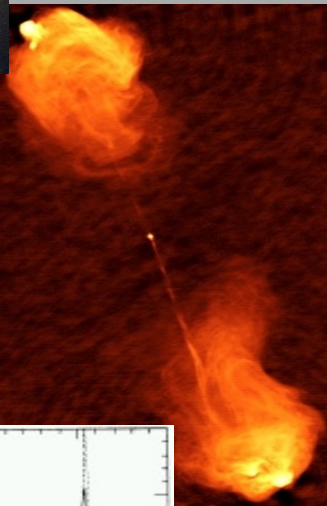
FR I



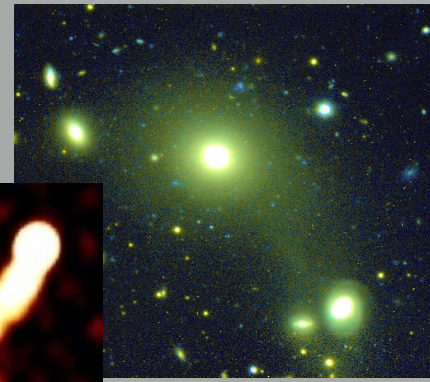
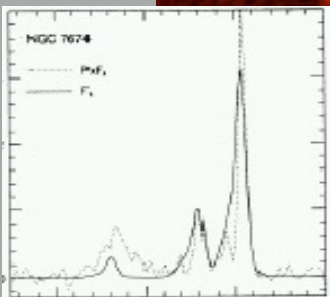
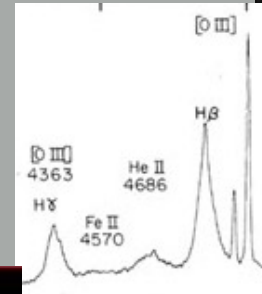
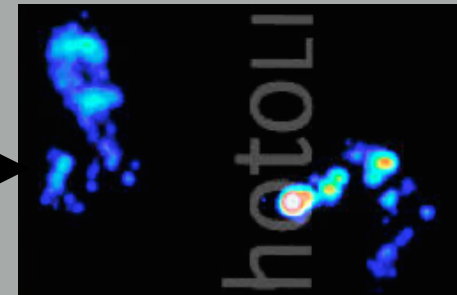
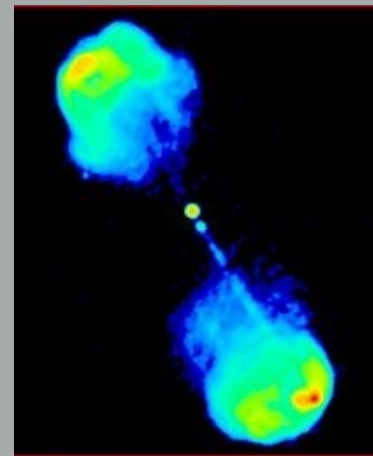
Quasar

$$L_{178\text{MHz}} \geq 2 \times 10^{25} \text{ W Hz}^{-1}$$

FR II



relativistically beamed
+ unobscured



- *FRI Quasar (Blundell Rawlings01)*
- *“Prevalence of FRI Quasars” (Heywood+07)*
- *MOJAVE Blazars: 23% BLLacs have FR intermediate luminosities, 60% have hotspots (Kharb+ 2010)*
- *Kharb & Shastri 2004*

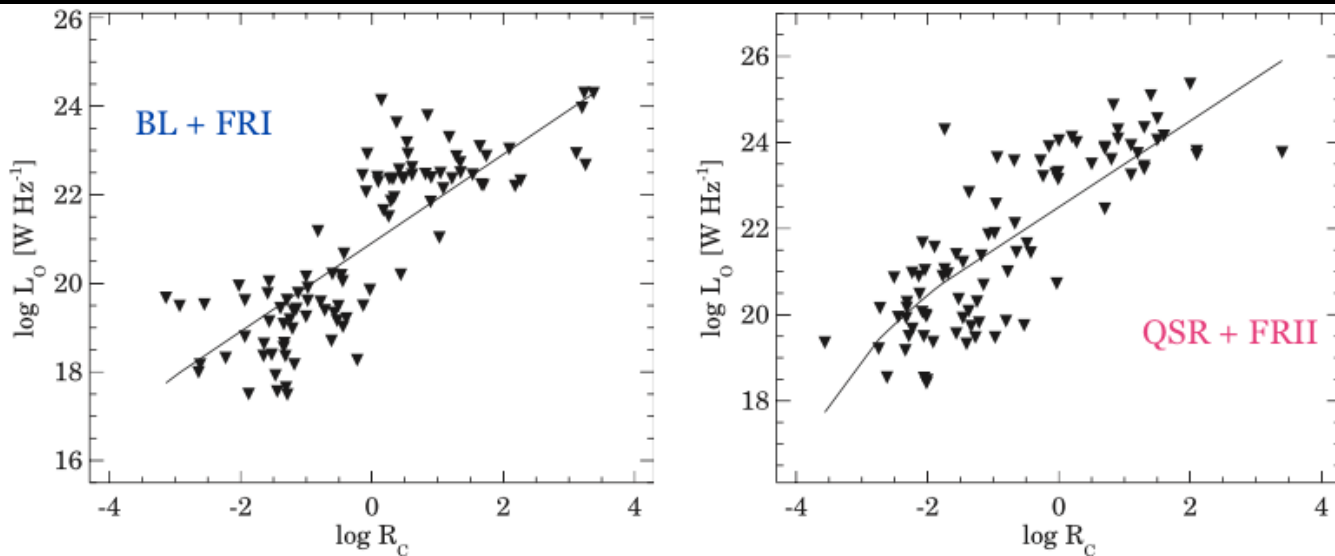
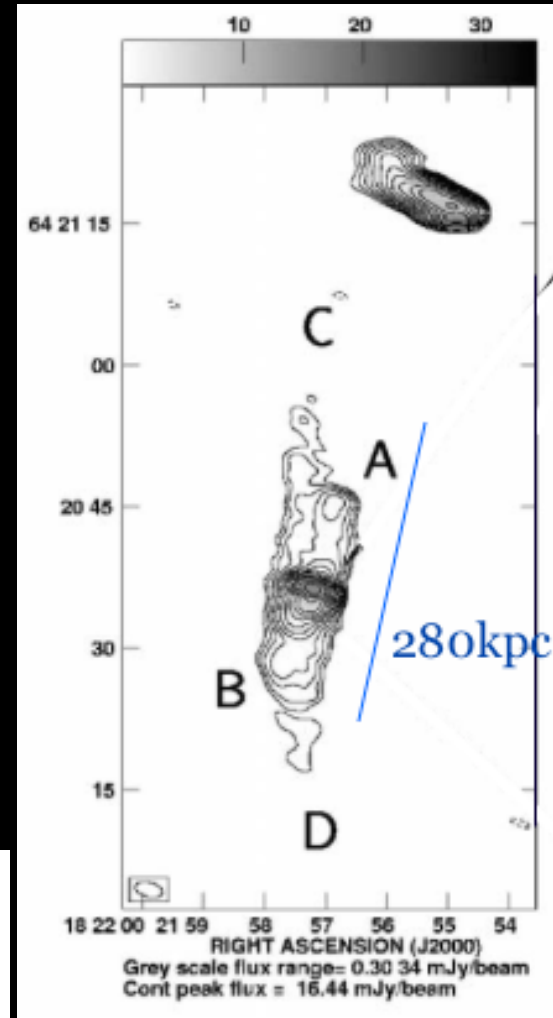
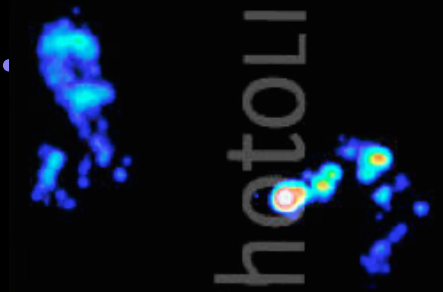
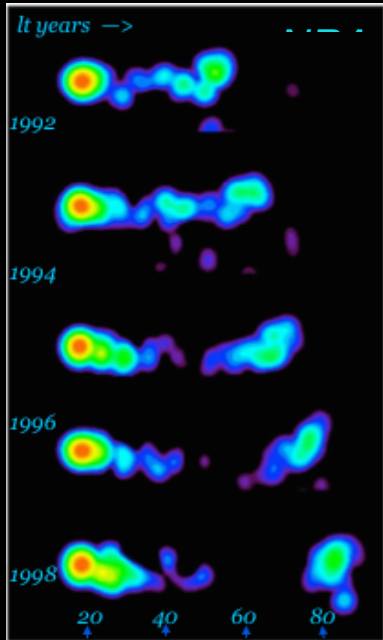


Fig. 5. Best fits to the FRI (left) and FRII (right) populations using only a “Jet+Torus” model. Table 2 lists the model parameters.

Examine the BLAZAR divide.



3rd Fermi LAT Catalogue (3FGL) &

3LAC: 3rd LAT AGN Catalogue: 1444 AGN

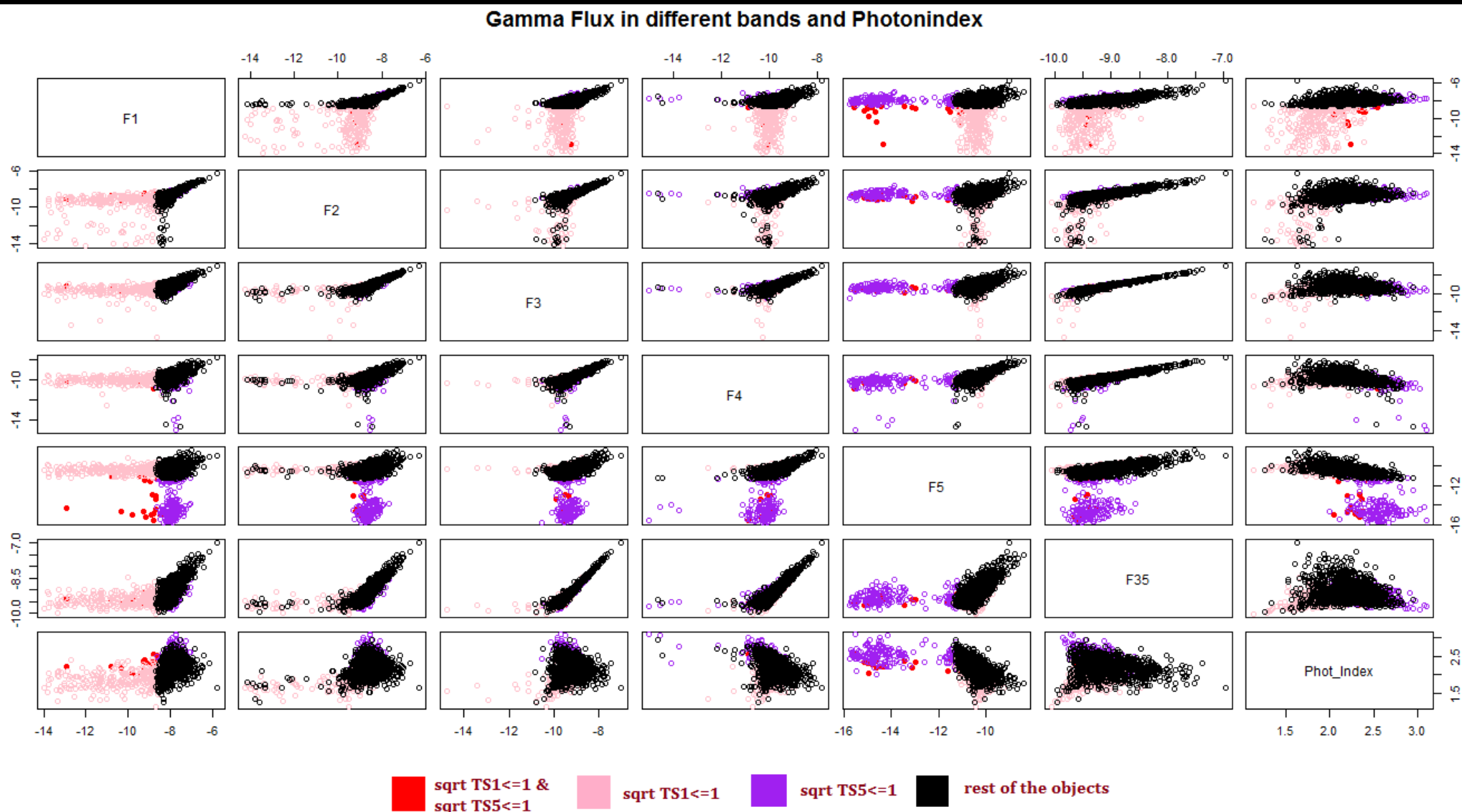
Classification done in 3FGL/3LAC into:

Quasars & BL Lacs,

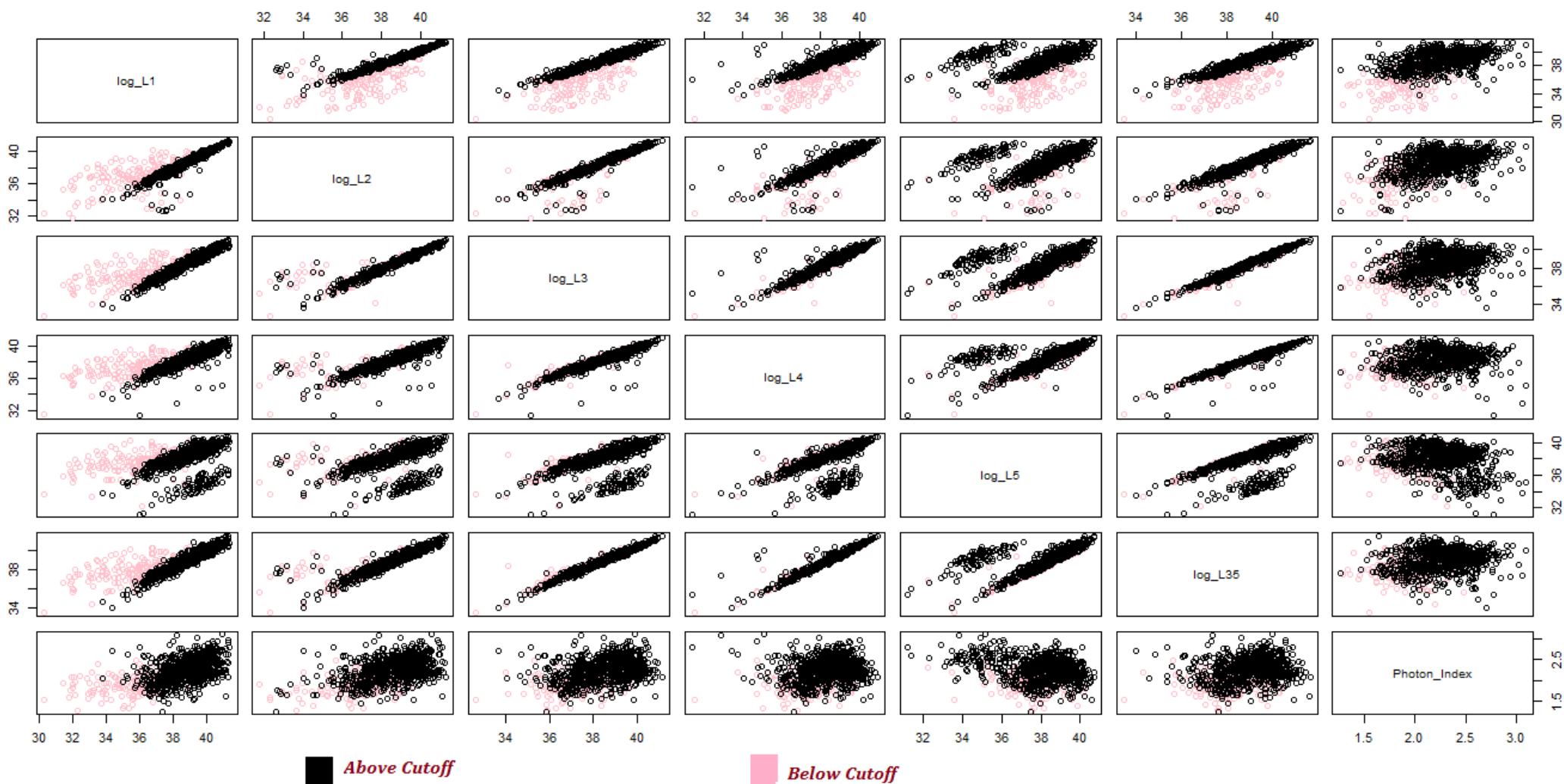
i.e. with & without observable emission-line regions.

and MOJAVE data

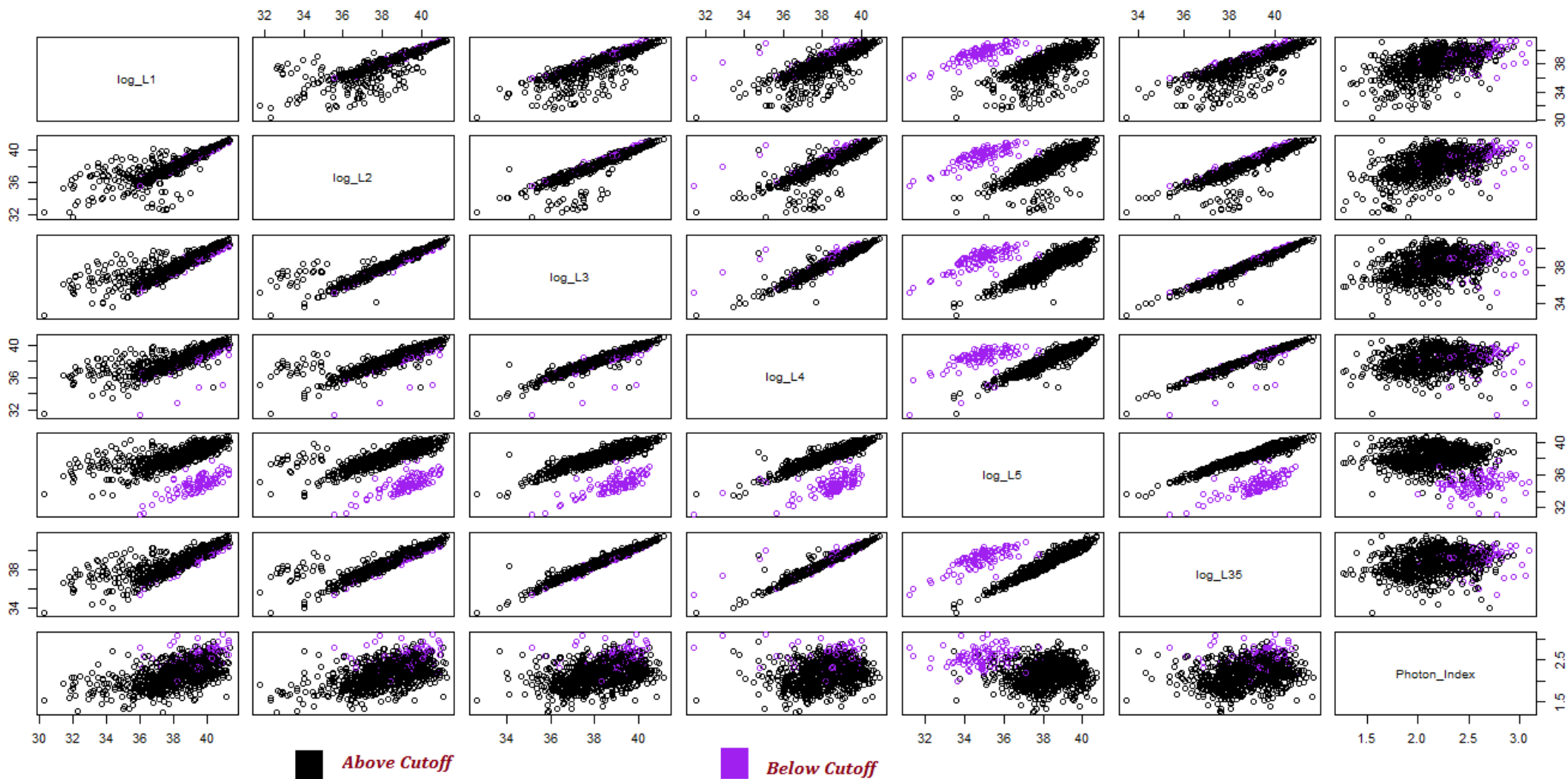
*Do not include all the objects in the 3LAC sample:
de-select those with low statistical significance*



Gamma Luminosity in different bands and Photonindex Cutoff sqrt TS1=1



Gamma Luminosity in different bands and Photonindex Cutoff sqrt TS5=0



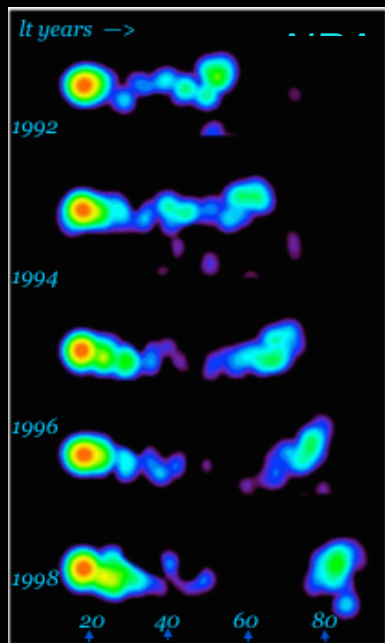
3rd Fermi LAT Catalogue (3FGL) &

3LAC: 3rd LAT AGN Catalogue:

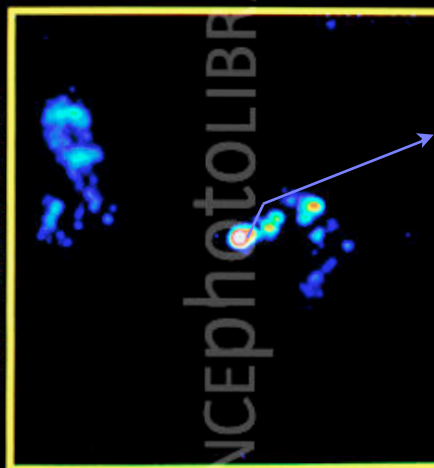
*813 AGN have fluxes measured by Fermi with
“reasonable” statistical significance*

571 have redshifts, of which

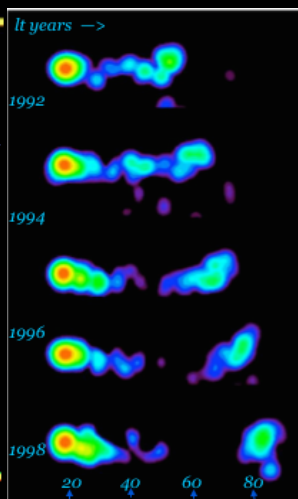
250 Quasars & 254 BL Lacs



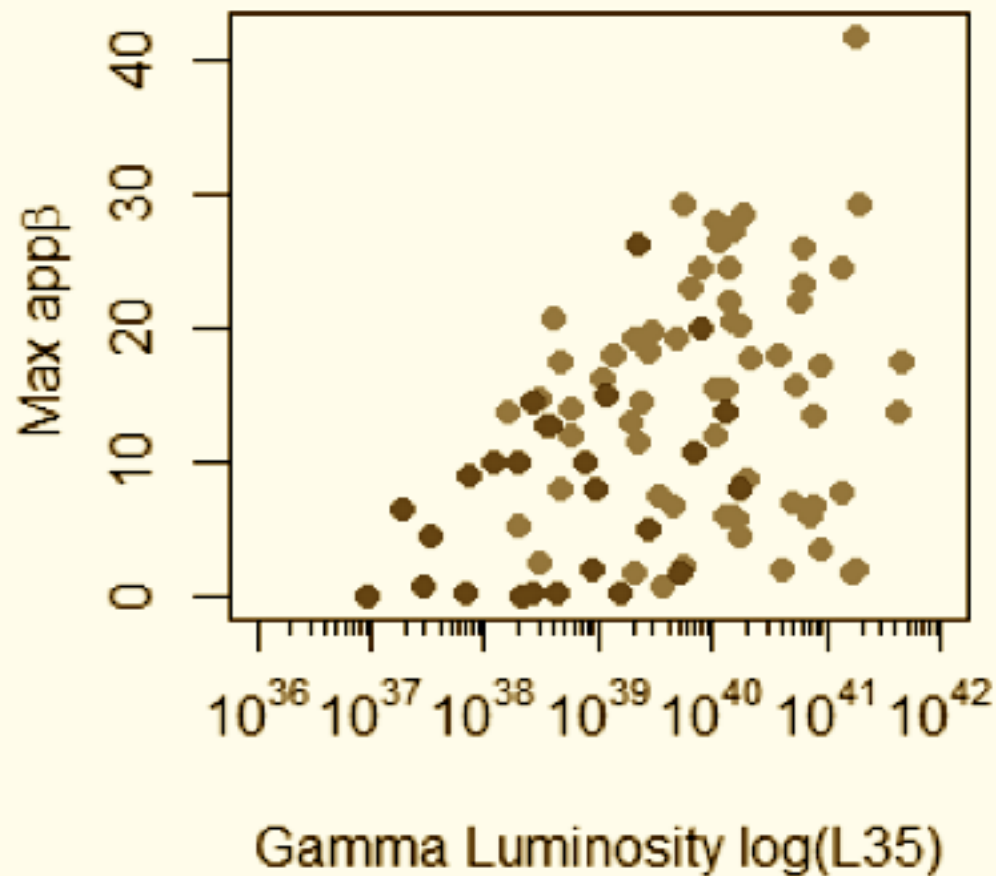
3C279 MERLIN 1.67GHz



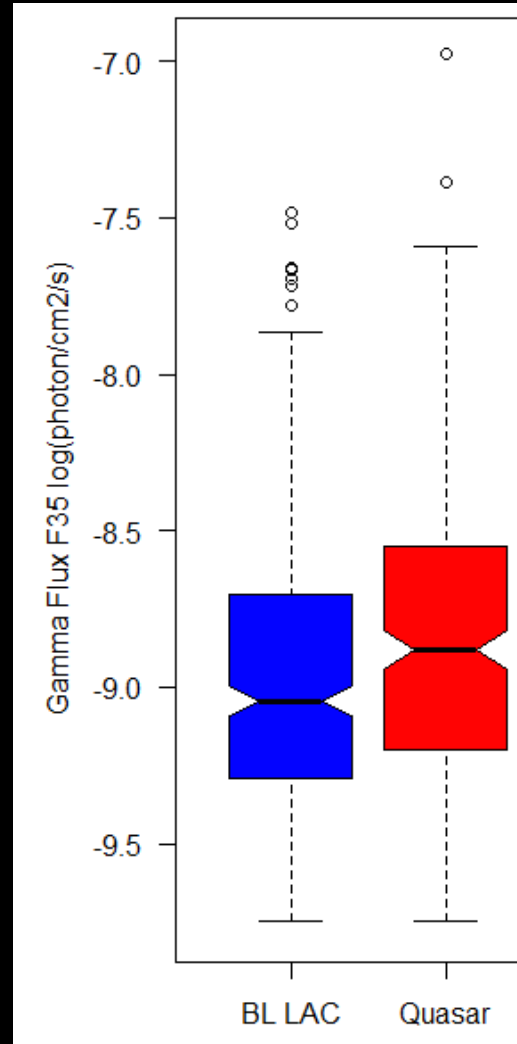
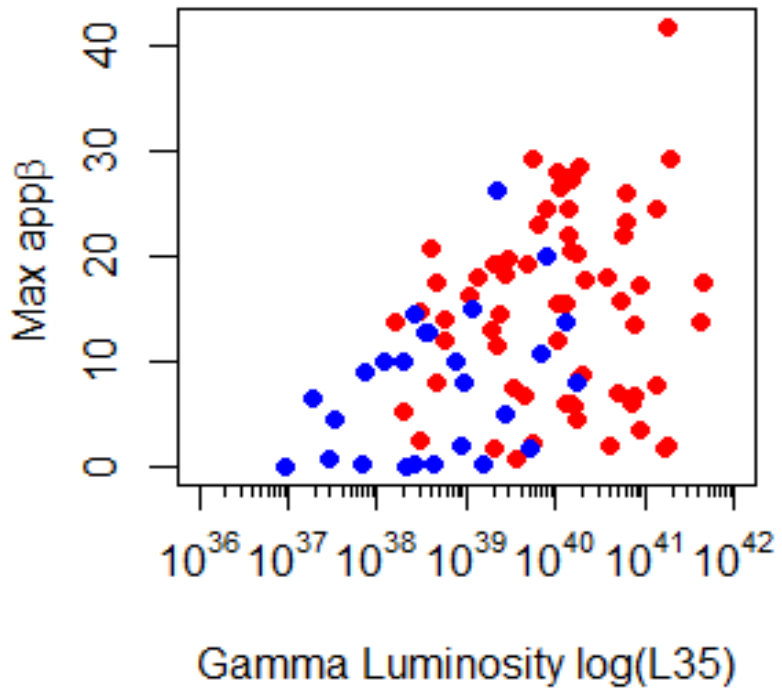
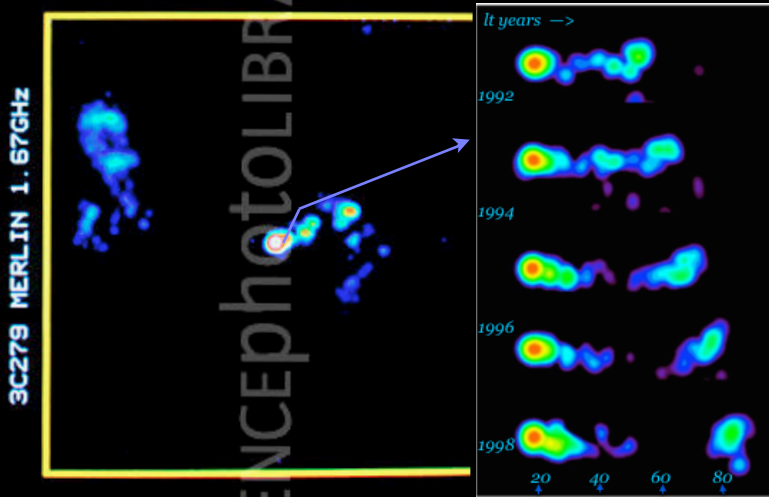
SCIENCEPHOTOLIBRARY



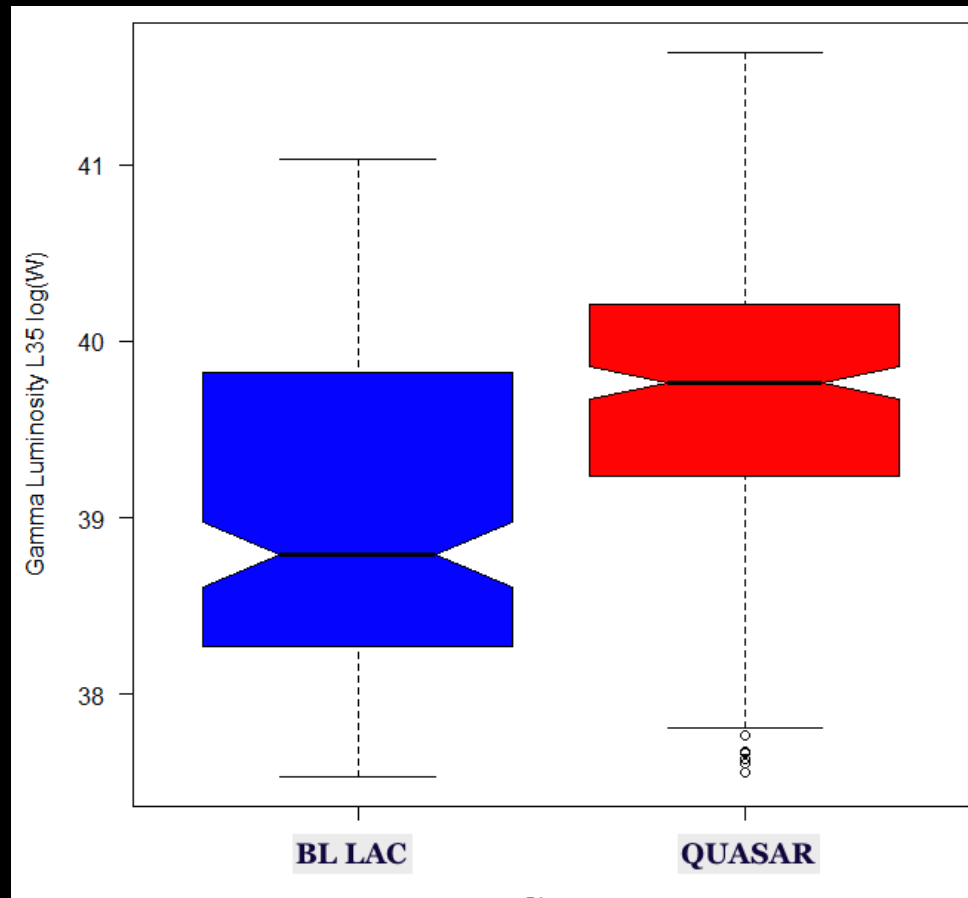
Maximum apparent speed measured by the MOJAVE project (Lister+ 2010):



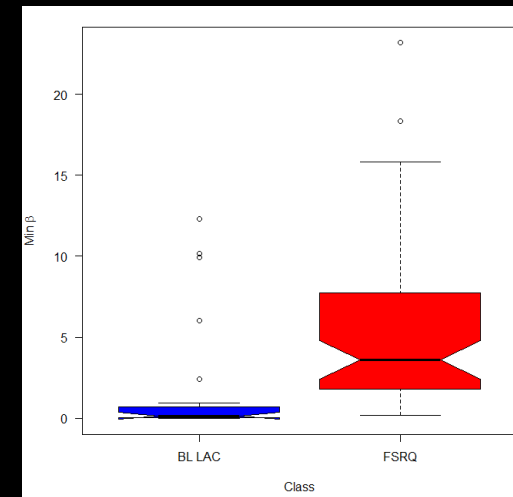
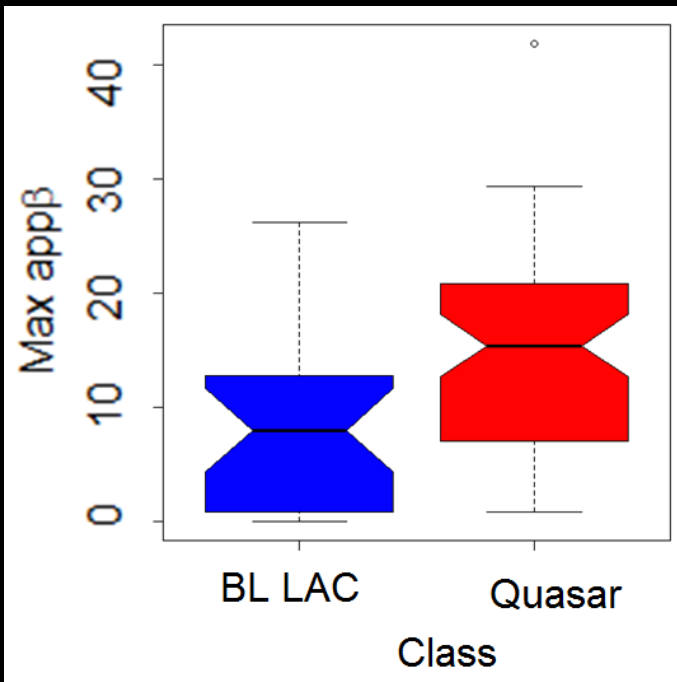
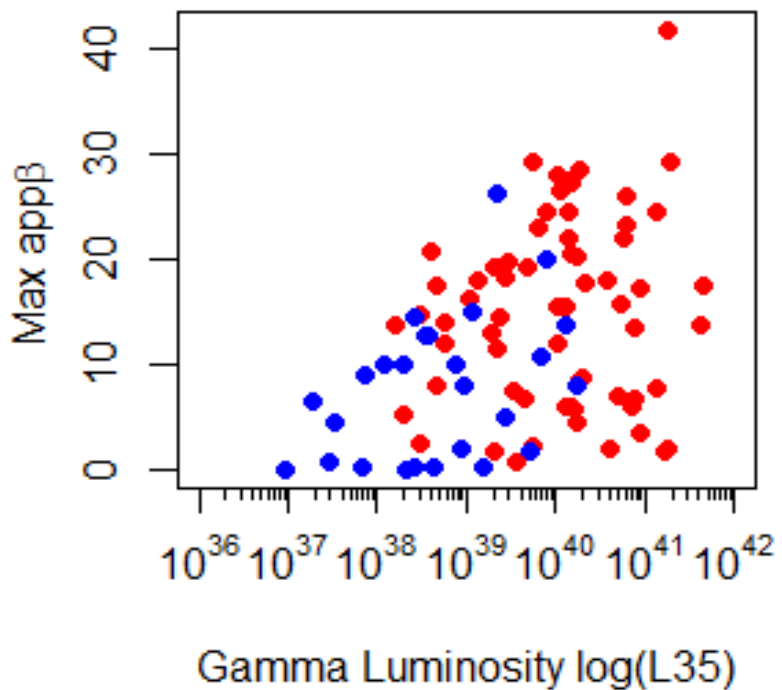
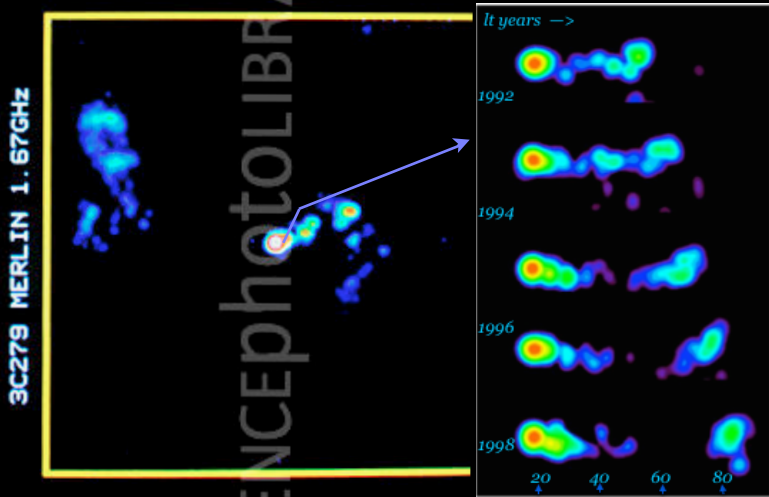
Maximum apparent speed measured by the MOJAVE project (Lister+ 2010):

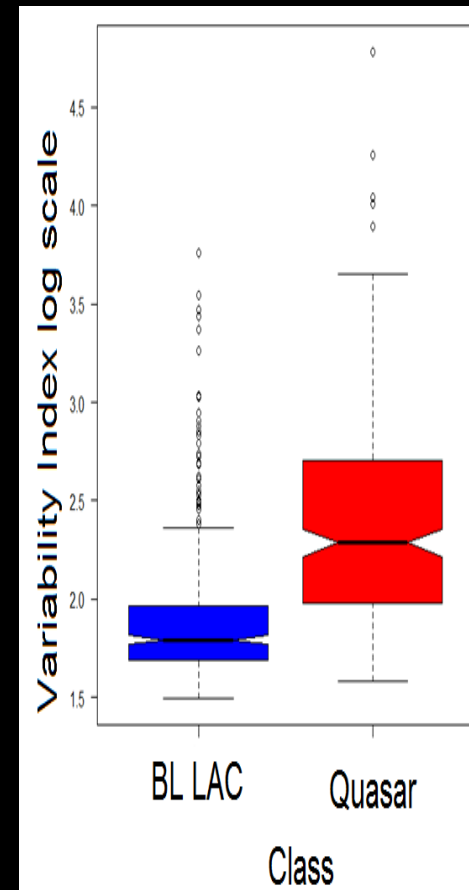
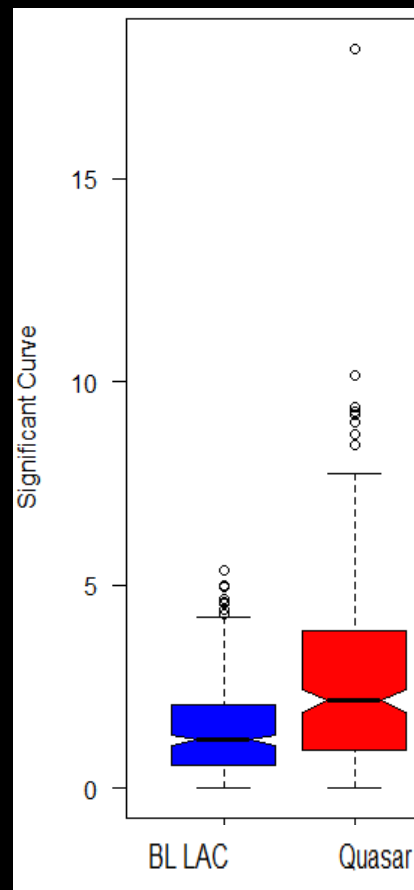
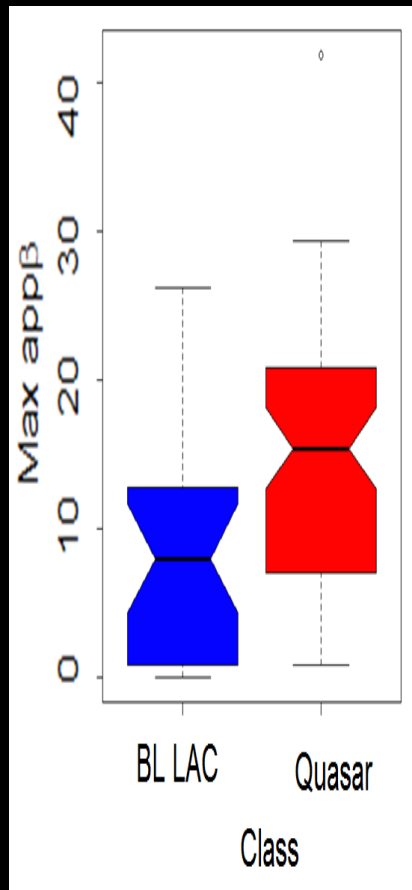


redshift: 0.25 - 2.5

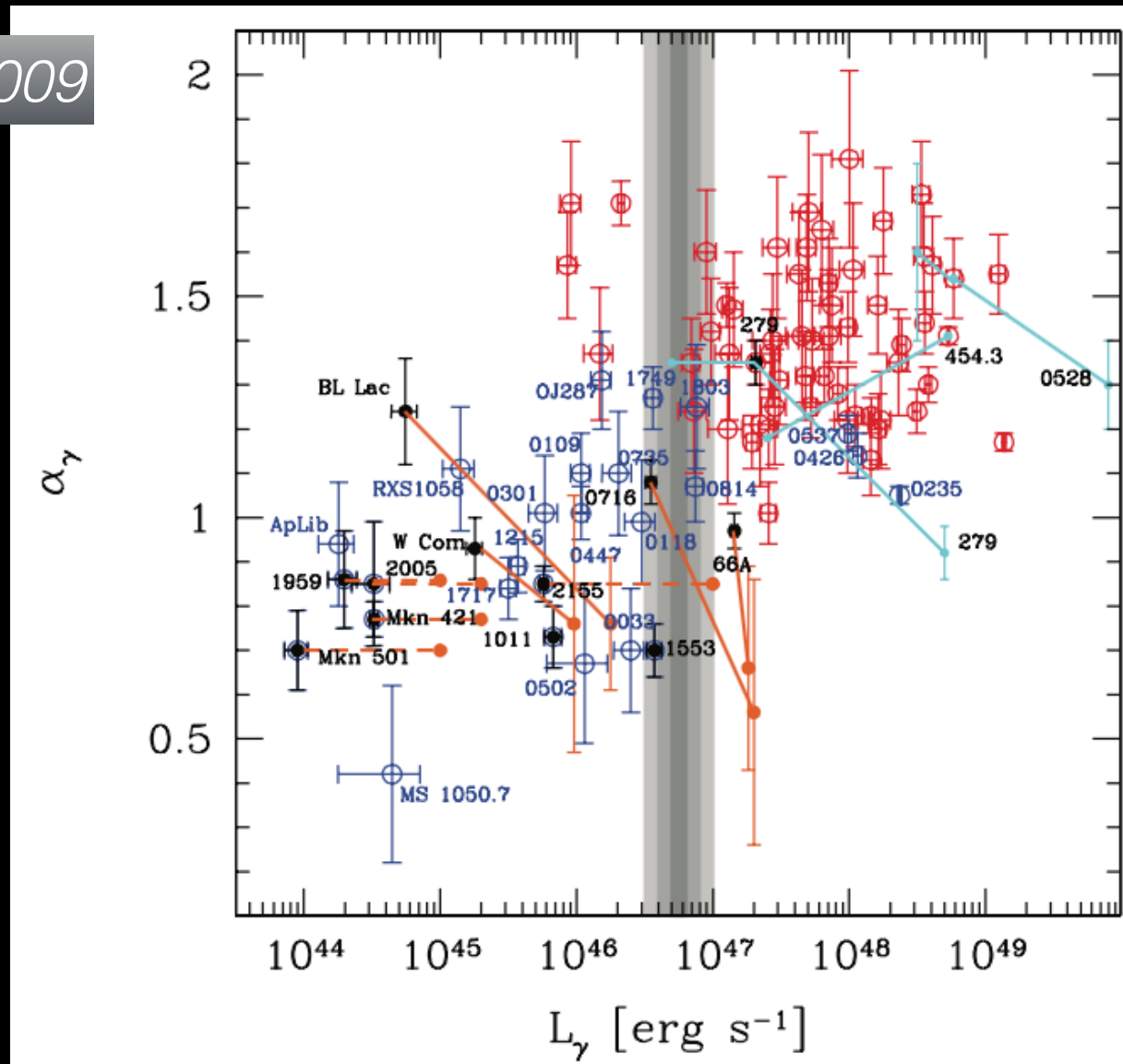


Maximum apparent speed measured by the MOJAVE project (Lister+ 2010):



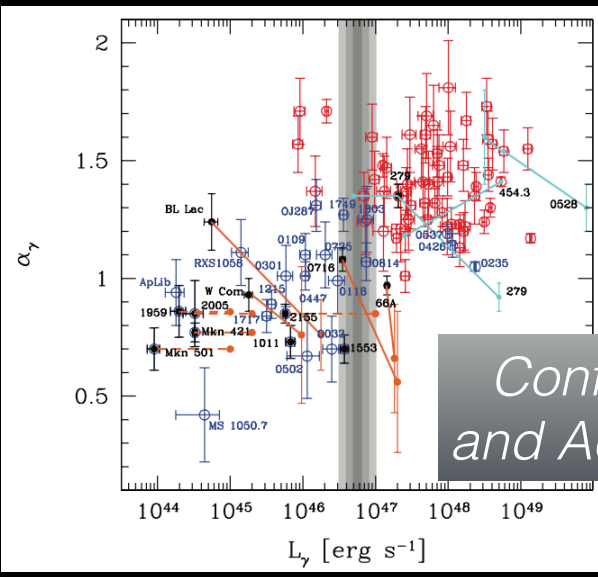


(Also true for the whole $3LAC$ sample: Ackermann +2015)

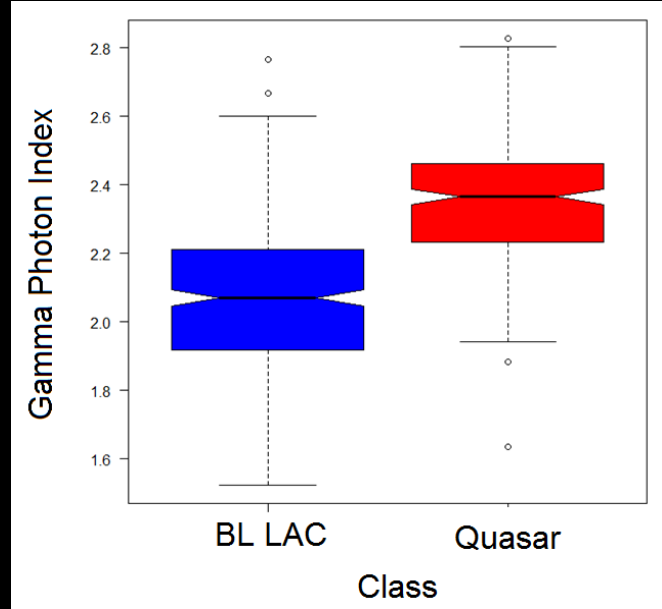


BL Lacs: harder spectra: photon-starved environment

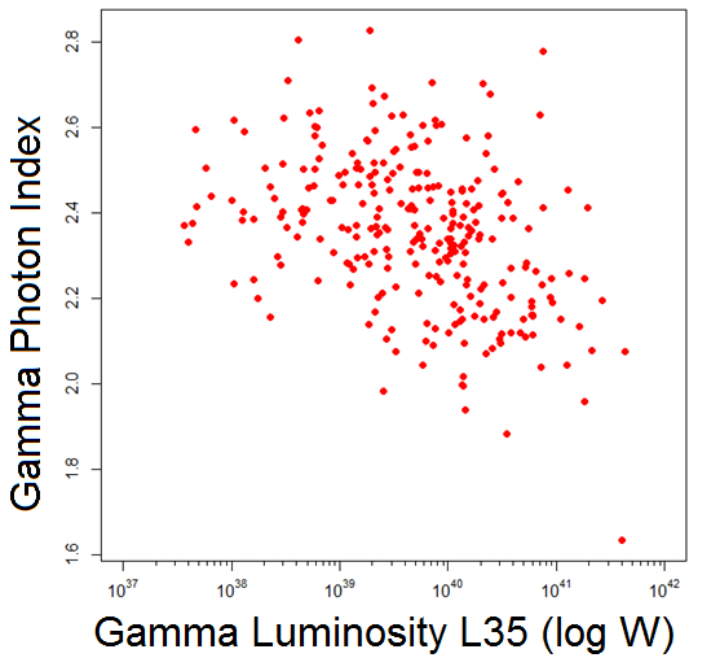
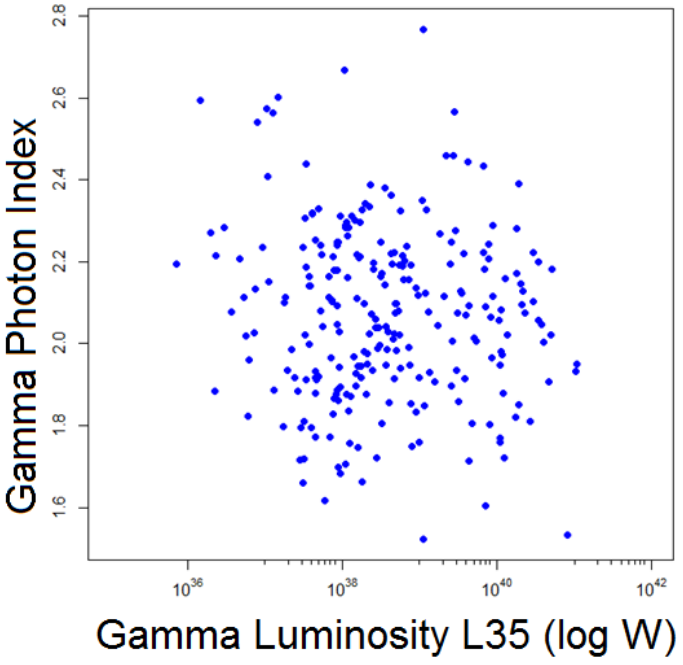
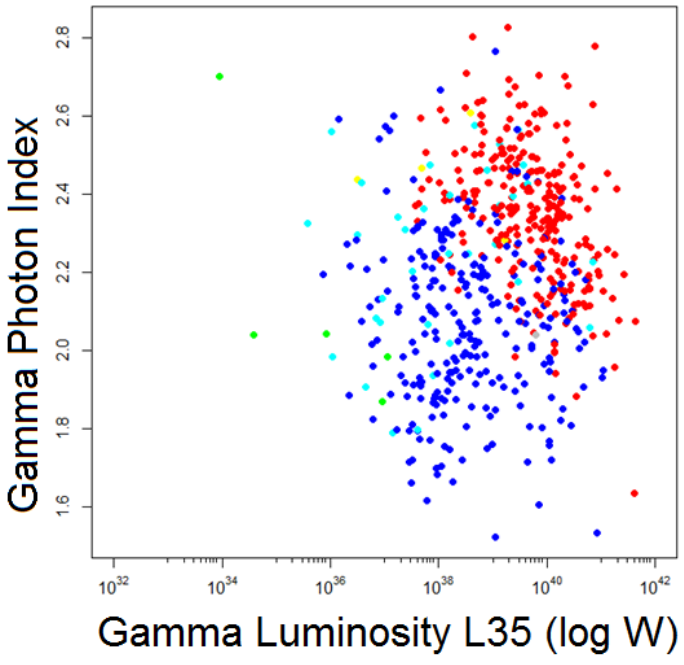
Blazar divide: continuity and not a dichotomy?



*Confirmed by Ackermann+2011,
and Ackermann+2015 (using 3LAC)*

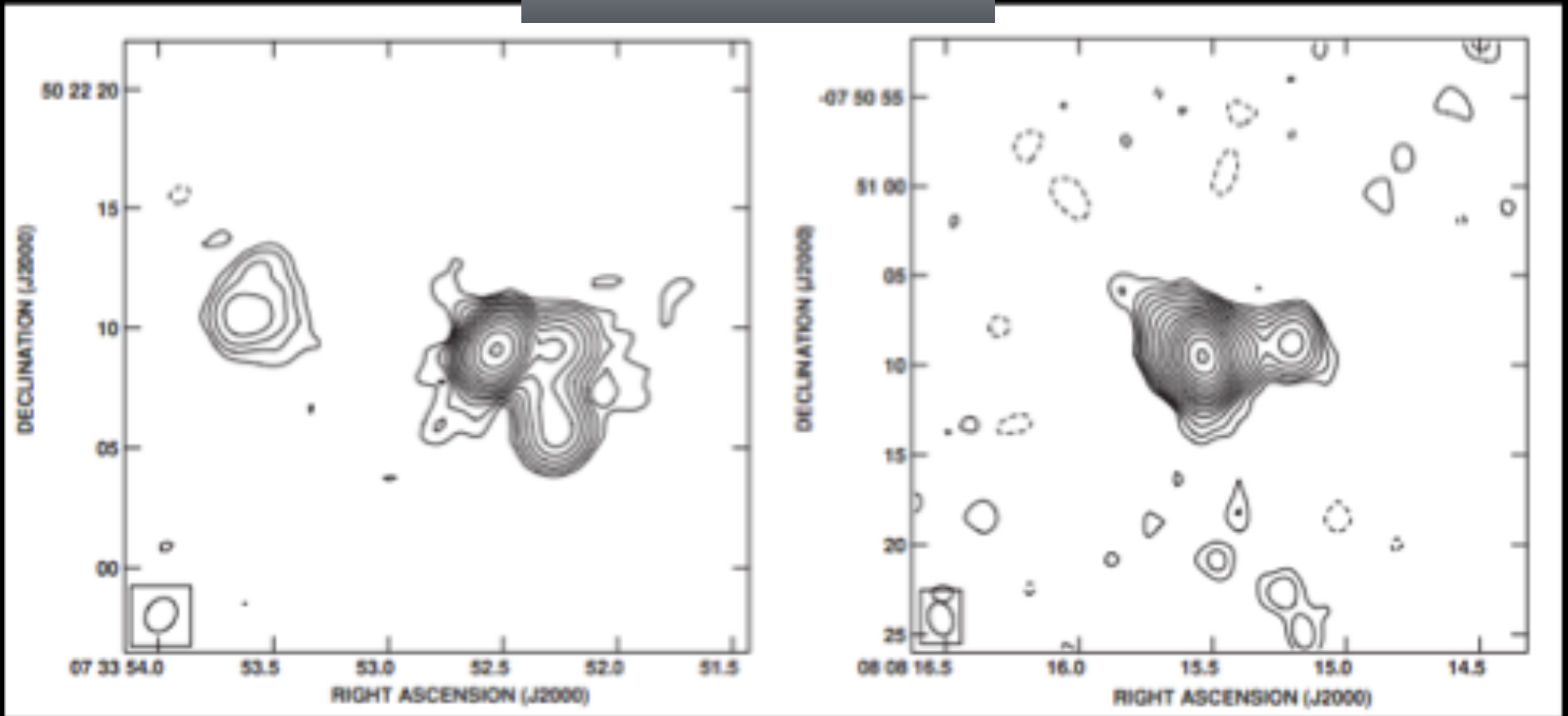


Photon Index vs Gamma Luminosity L35



Suggests that the Blazar divide is a dichotomy

Kharb+2010 (MOJAVE)



*For Blazars:
Radio core-dominance may not be a reliable measure of orientation*

H0414+009

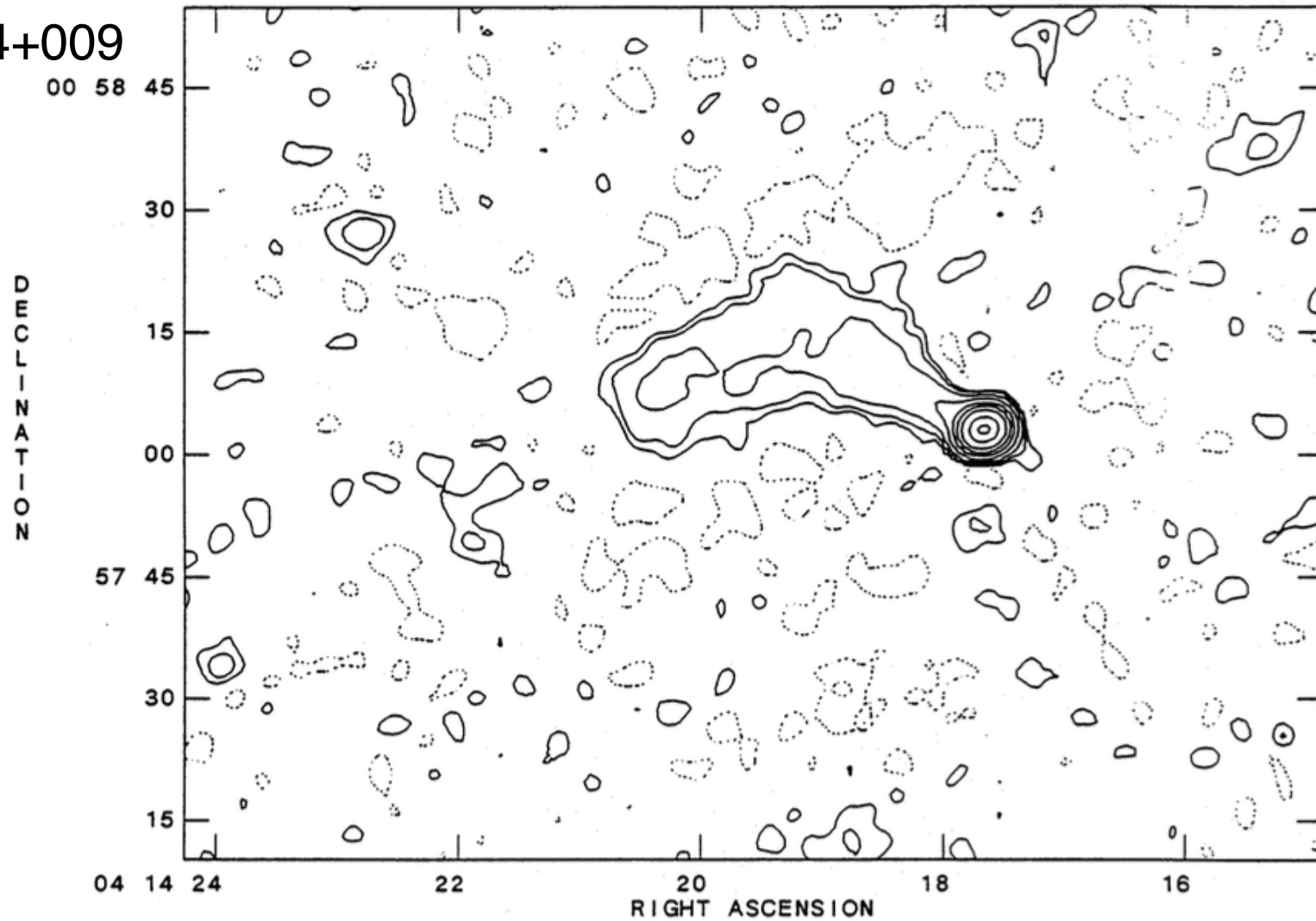
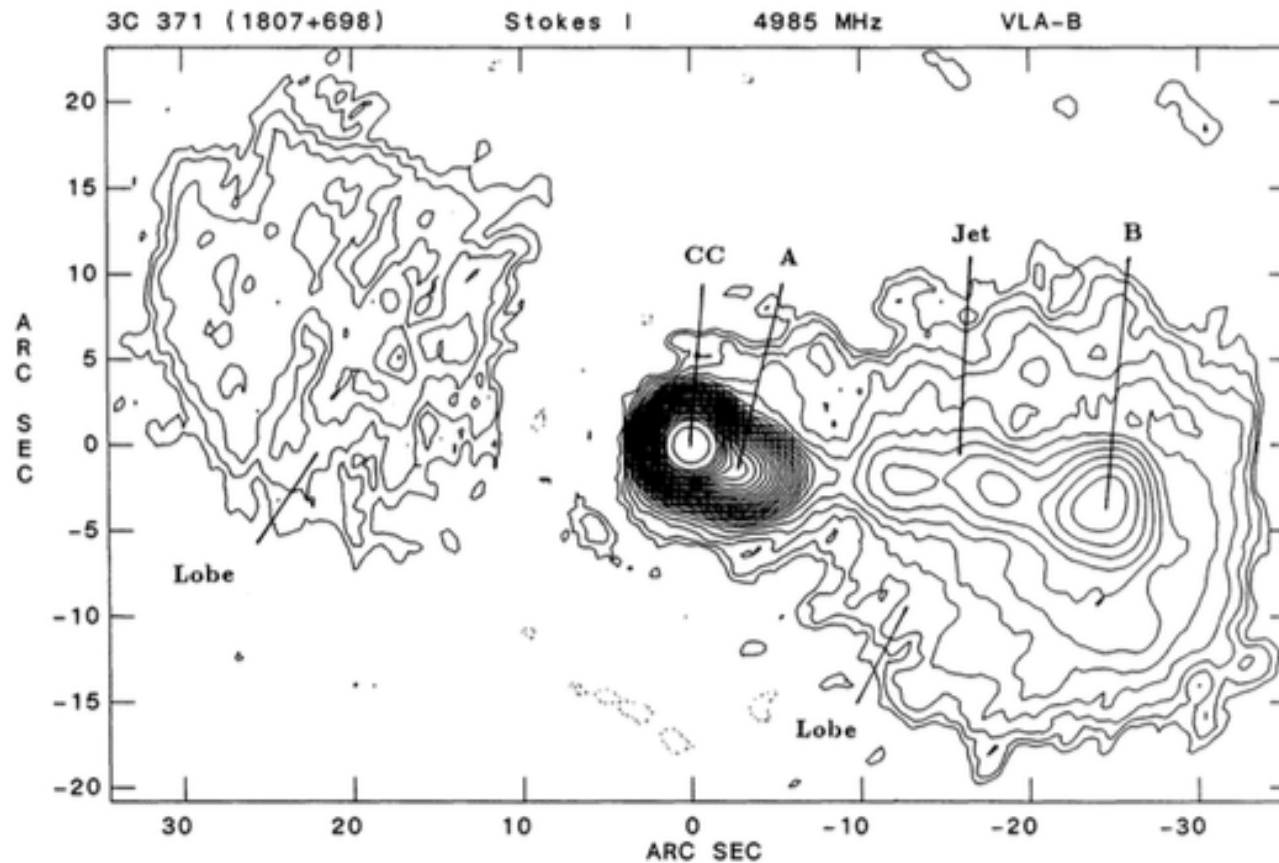


Figure 1. 20-cm VLA radio map. The peak flux density is $75.6 \text{ mJy beam}^{-1}$ and the contours are at $-0.15, 0.15, 0.3, 0.7, 2, 5, 10, 20, 50$ and 90 per cent of the peak.

McHardy+1992

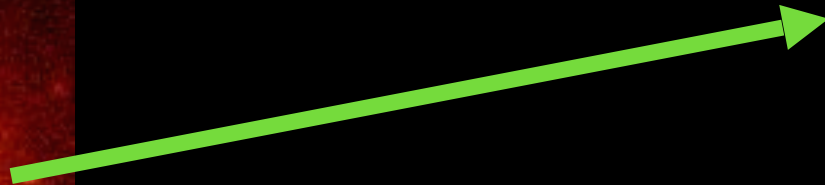


peak surf bri ratio of lobes:
 $26.83/2.683 = 10$

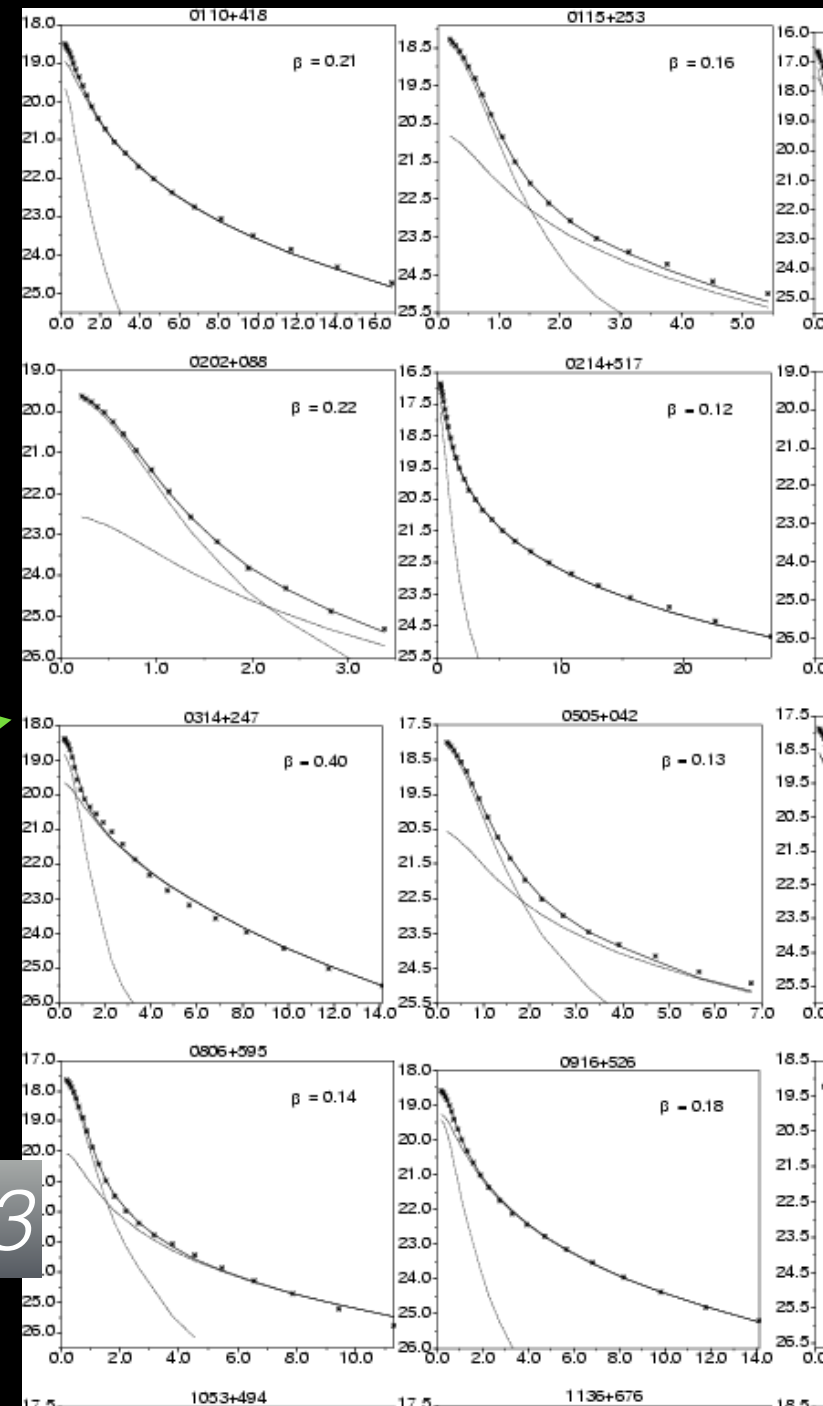
LEVS = 1.1189E-04 * (-1.93, -1.39, -1.00, 1.000,
 1.389, 1.931, 2.683, 3.728, 5.179, 7.197, 10.00,
 13.89, 19.31, 26.83, 37.28, 51.79, 71.97, 100.0,
 138.9, 193.1, 268.3, 372.8, 517.9, 719.7, 1000.,
 1389., 1931., 2683., 3728., 7143.)

FIG. 1.—Naturally weighted CLEANed image of 3C 371 at 4985 MHz from VLA B-configuration data. Origin is at R.A.(1950) = $18^{\text{h}}07^{\text{m}}18^{\text{s}}.54$ and Decl.(1950) = $+69^{\circ}48'57''.0$. Scale is $1'' \sim 0.7h^{-1}$ kpc. Lowest contour is 0.007% of peak of $1534 \text{ mJy beam}^{-1}$. Contours are logarithmic, with 7 given per decade. Uppermost contour shows restoring beam at FWHM (2.1). The compact core (CC), components A and B, the jet, and the eastern and western lobes are labeled. The peaks of components A and B are 5.0% and 0.25%, respectively, as bright as the CC.

Measure of orientation?

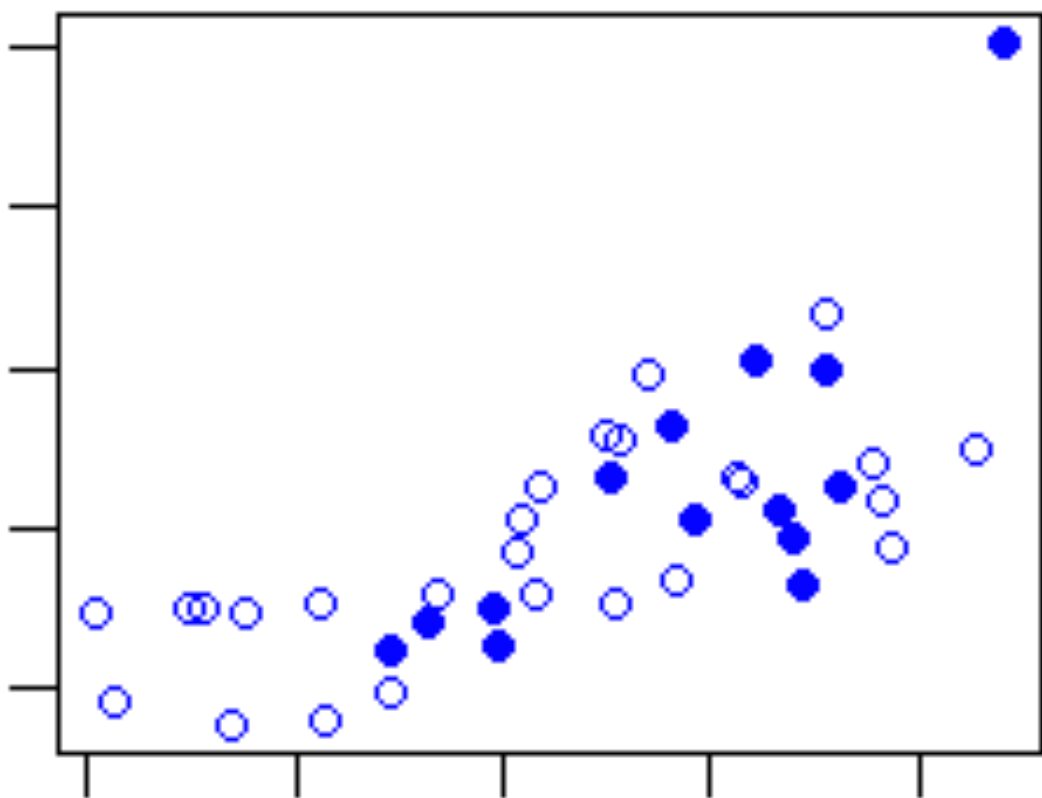


Nilsson+ 2003

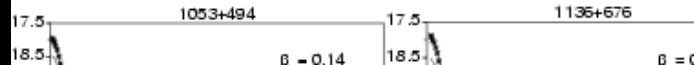
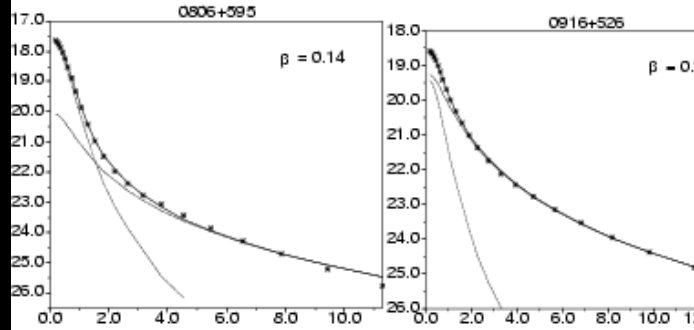
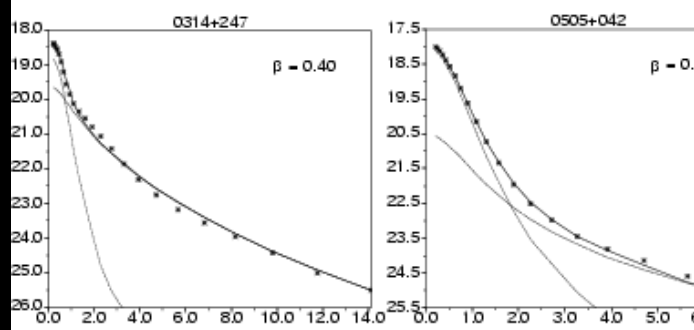
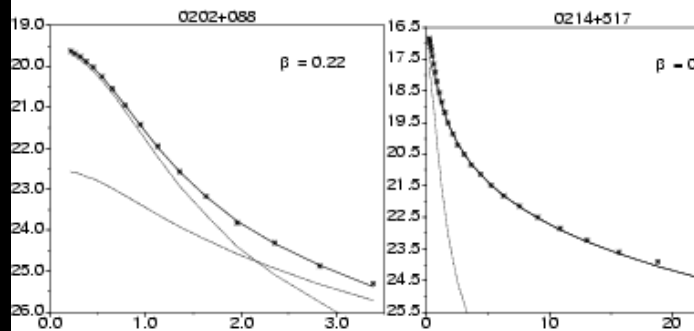
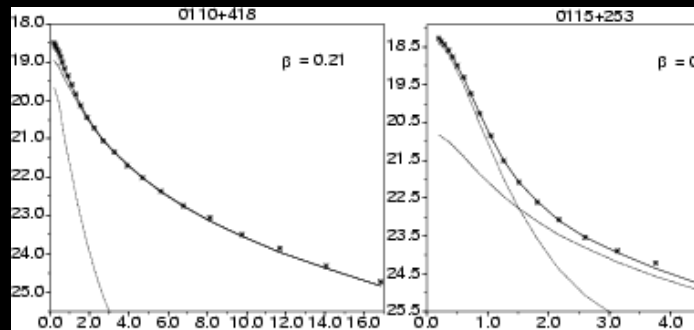


Gamma Luminosity $\log(L_{35}) W$

37 38 39 40 41



L_{nu}/L_{gxy} log scale



Conclusions:

- *The data are consistent with BLLac jets being launched in a photon-starved environment (gamma-ray photon index softer for quasars)*
- *The maximum apparent jet speeds, the variability indices and significance of non-plaw fits higher for quasars (also Ackermann+15)*
- *dependence of photon index on gamma-ray luminosity different for quasars & BLLacs: consistent w/ Blazar divide being a dichotomy*
- *Exploring the Blazar divide quantitatively requires a robust orientation indicator*
- *radio core-dominance is not a robust orientation indicator for blazars*
- *optical nuclear-to-galaxy ratio could provide a better proxy*



Thank you!

