A new sample of faint blazars

work in progress

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Blazars: an extreme class of Active Galactic Nuclei

FSRQs (high luminosity radio galaxies)

BLLacs (low luminosity radio galaxies)

Characteristics: high luminosity

rapid variability

high polarisation

Emission: non-thermal origin, i.e. synchrotron and I.C.

Radio band: core-dominated objects

apparent superluminal speeds

Available blazar samples:

High limiting flux densities ~ 1 Jy

X-ray band: few times 10^{-13} ergs cm^{-2} sec^{-1}

Small sizes (30 – 50 objects)

Deep X-ray Radio Blazars Survey

(Perlman et al. 1998; Landt et al. 2001)

Cross-correlation ROSAT sources (White, Giommi & Angelini 1995)
radio sources with flat radio spectra
(Gregory et al. 1996; White & Backer 1992; Griffith & Wright 1993)

flux density down to ~ 50 mJy at 5 GHz

power down to ~ 10^{24} W Hz^{-1}

nearly complete optical identification

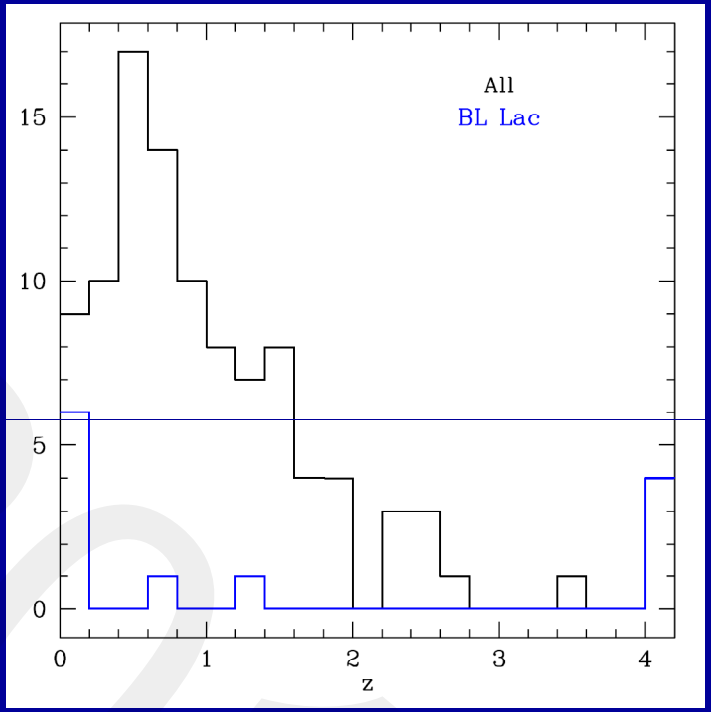
About 300 objects listed

includes both FSRQs and BL Lac sources

DXRBS sources selected : 103

Selection criteria : Dec > — 20 deg

A complete flux limited sample
of faint blazars



redshift distribution

Blazars are γ-ray emitter candidates

EGRET → 130 blazars detected

Fermi Gamma-Ray Space Telescope → 20,000 expected detections

Investigation

Effelsberg observations:

a) spectral index definition

b) flux density variability

c) polarised emission

Source extraction from NVSS and FIRST

EVN observations:

a) fringe detection

b) imaging

Effelsberg observations

Frequencies:	2.64 GHz	4.85 GHz	8.35 GHz	10.45 GHz
Bandwidth:	80 MHz	500 MHz	1100 MHz	300 MHz
Observing mode:	standard cross-scans (4 or 8)			
Scan length:	16 ’	12 ’	8 ’	6 ’
Scan speed:	45 ’/ min	45 ’/ min	40 ’/ min	30 ’/ min

Errors: Calibration 2%
Noise 2 mJy
Confusion 1.5, 0.45, 0.17, 0.08 mJy

Results

Spectral Index

14 % inverted spectrum

6 % spectral index steeper than 0.7 ($S \alpha \nu^{-\alpha}$)

80 % complex spectral index
flattening at higher frequencies - FSRQs

Polarised emission

Frequency	m_{limit}	Pol.Sources	m_{median}
2.64 GHz	≥ 3 %	25	$4.9 \pm {}^{1.1}_{0.4}$ %
4.85 GHz	≥ 2 %	36	5.8 ± 0.9 %

Flux density variability

Effelsberg *versus* GB6 at 5 GHz

(S > 18 mJy; σ ≈ 5 mJy)

~ 50 % of sources exhibit flux density variability > 20 %

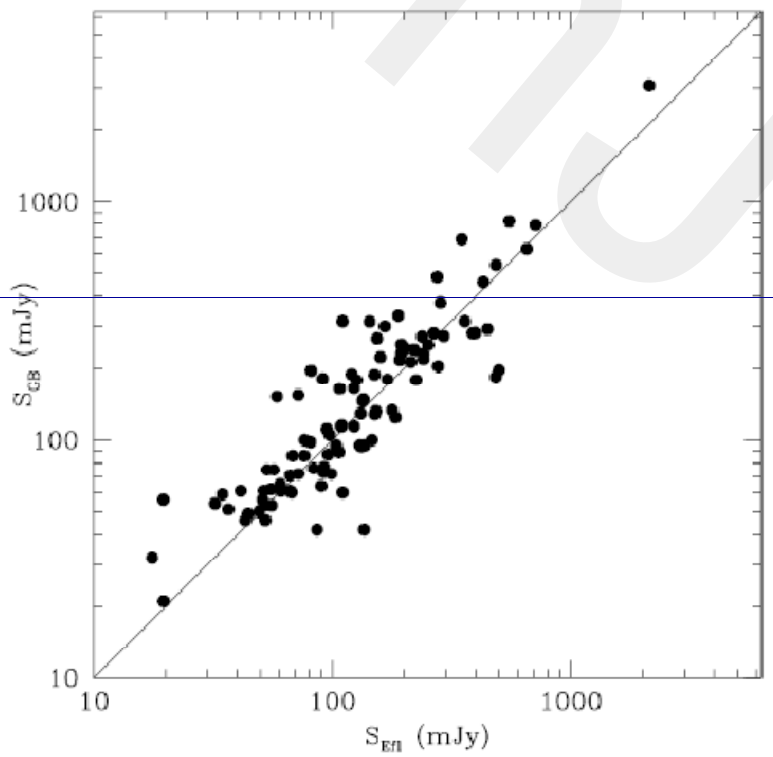


Fig. 1. Effelsberg flux densities *vs* GB6 flux densities at 5 GHz. The straight line means a ratio of 1. The size of a dot represents a flux density error of 10%.

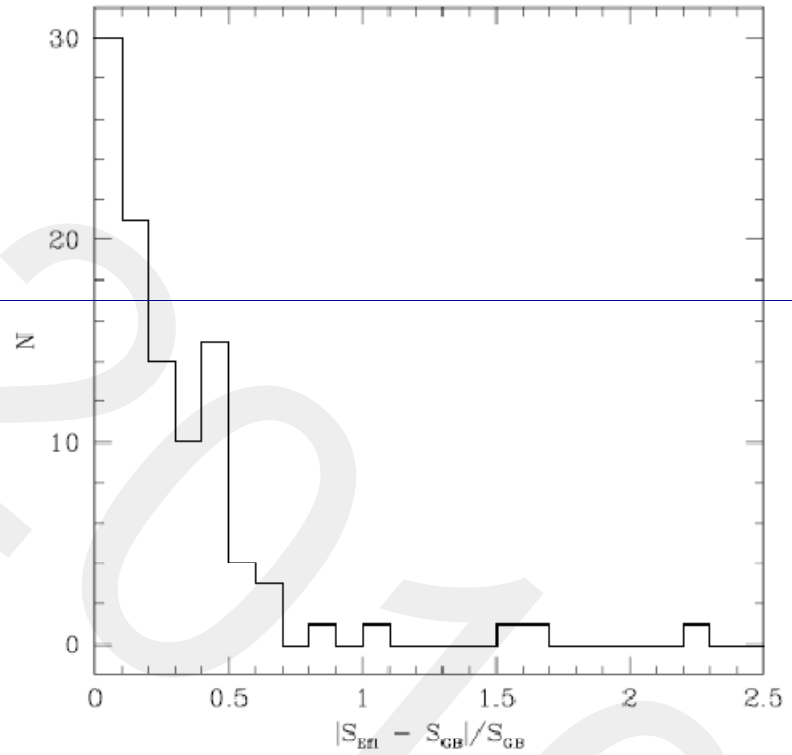


Fig. 2. Cumulative histogram of the ratio between the Effelsberg flux density minus the GB6 flux density module and the GB6 flux density.

EVN observations

Frequency	5 GHz
Stations	11
Recording	512 Mbits, 2 bit sampling (~ 2.5 TBytes/station)
Strategy	5 x 6 minutes scans per source
Observations	Session 3, 2009 → 18 sources Session 2, 2010 → 45 sources
Correlation	MPIfR DiFX software correlator 1 sec integration time → field of view ~ 11”
Analysis	AIPS, DIFMAP

Preliminary results

All the 18 sources observed were detected

Peak flux density 4.7– 377 mJy/beam

Total flux density 5.6– 377 mJy

3σ error ≈ 0.1 mJy/beam

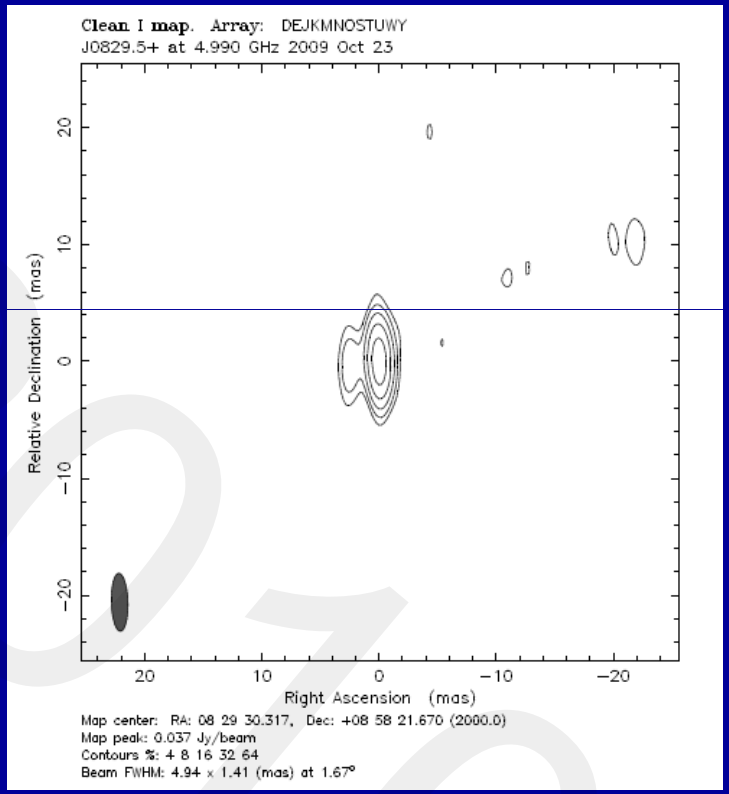
T_b 0.1– 27.6 10^{10} K; $T_{b\,median} \approx 3.0\,^{+5.0}_{-2.0}\,10^{10}$K

12 exhibit a core-jet structure

6 are point-like (resolution better than 5 mas)

S_{VLBI} much smaller S_{EF}

S_{VLBI} / S_{EF} median $\approx 0.44\,^{+0.14}_{-0.18}$



Fermi and the DXRBS sample

8 out of 103 sources detected by *Fermi LAT*

(first year list, Abdo et al. 2010)

2 are among the 18 sources observed with the EVN

WGAJ0847.2 + 1133

WGAJ0937.1 + 5008

WGAJ0847.2 + 1133

BL Lac at $z = 0.198$

Spectral Index steep (between 2.65 GHz and 4.85 GHz)
inverted (between 4.85 GHz and 8.35 GHz)

Point-like source at milli-arcsec resolution

$S_{VLBI} / S_{EF} = 0.28$

≈ 50% flux density variability at 5 GHz

WGAJ0937.1+5008

FSRQ at z = 0.275

- point-like structure
- $S_{VLBI} / S_{EF} \approx 2.3$ (time scale 4 months)
- Inverted spectral index ($\alpha \approx -1.2$)
- 60 – 70 % flux density variability at 5GHz
- γ-ray variability index of 58
  (photon flux peak 1.6 10^{-7} photon/cm^2/s in June 2009)

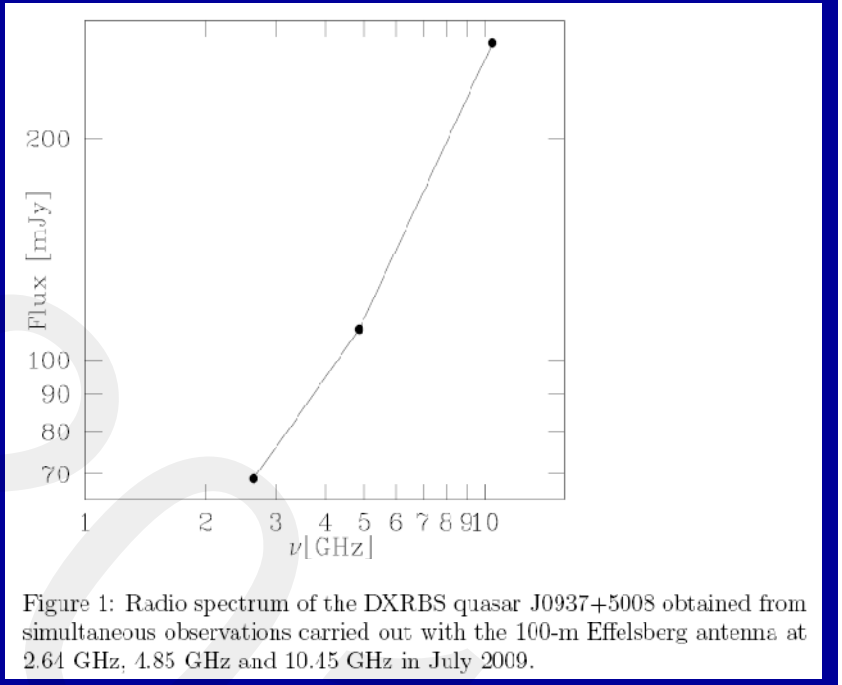


Figure 1: Radio spectrum of the DXRBS quasar J0937+5008 obtained from simultaneous observations carried out with the 100-m Effelsberg antenna at 2.64 GHz, 4.85 GHz and 10.45 GHz in July 2009.

Deserving follow-up monitoring observations to check for
- flux density variability
- structural changes

Summary

- We defined a comparison sample of 103 faint blazars
- Spectral index classification — 95 % are FSRQs
- About 50 % exhibit flux density variability higher than 20 % at 5 GHz
- About 35% exhibit polarised emission higher than 2 % at 5 GHz
- The first 18 sources observed with the EVN were detected
- 12 sources have a core-jet structure, 6 are point-like
- All but two sources show VLBI flux density < Effelsberg flux density
- WGAJ9037.1+5008 shows an increase in flux density by a factor 2.3
- 8 out of 103 sources detected by *Fermi*

Thanks for your attention