Deep Blazar surveys with Swift

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+ many collaborators:
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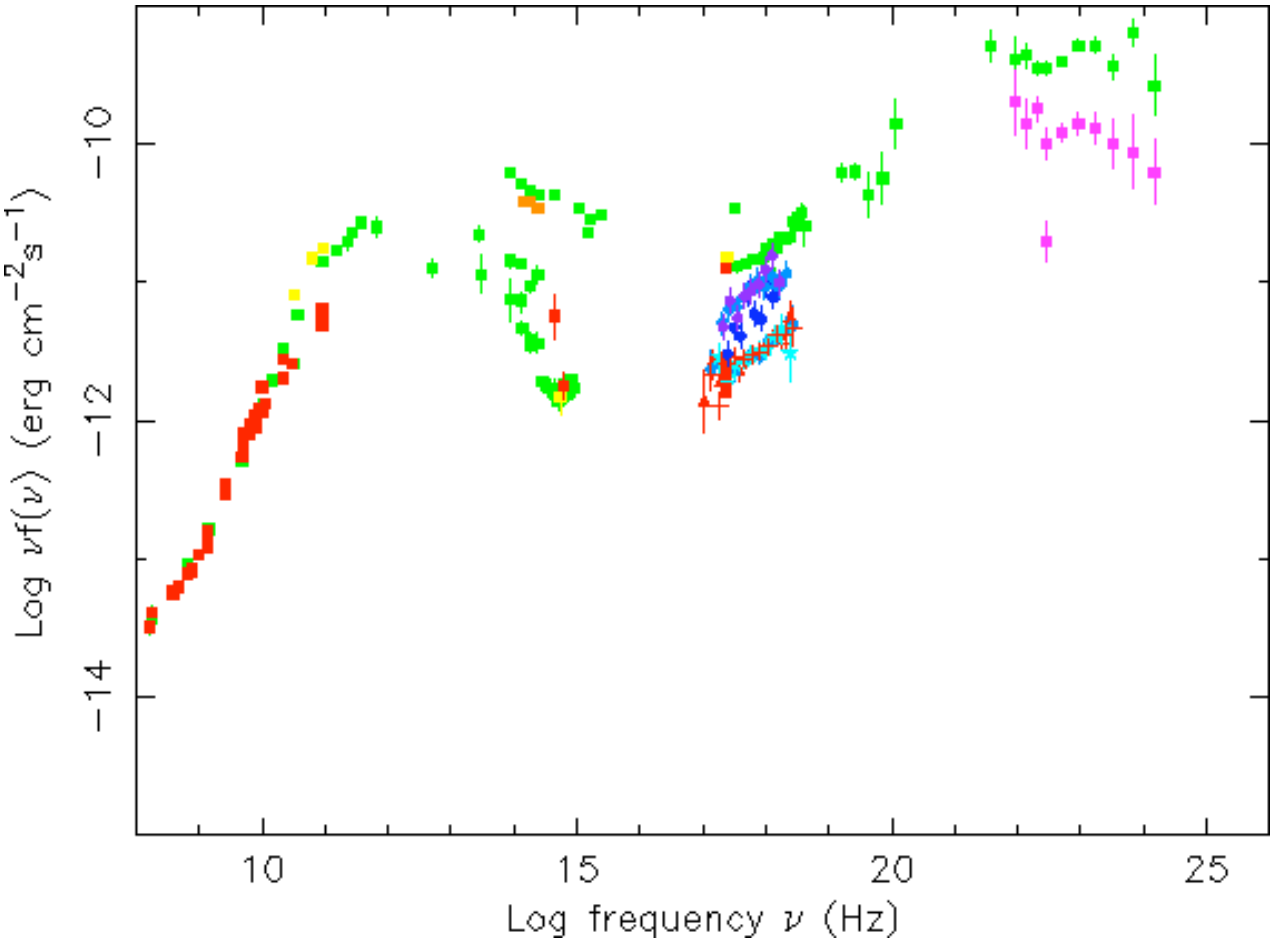
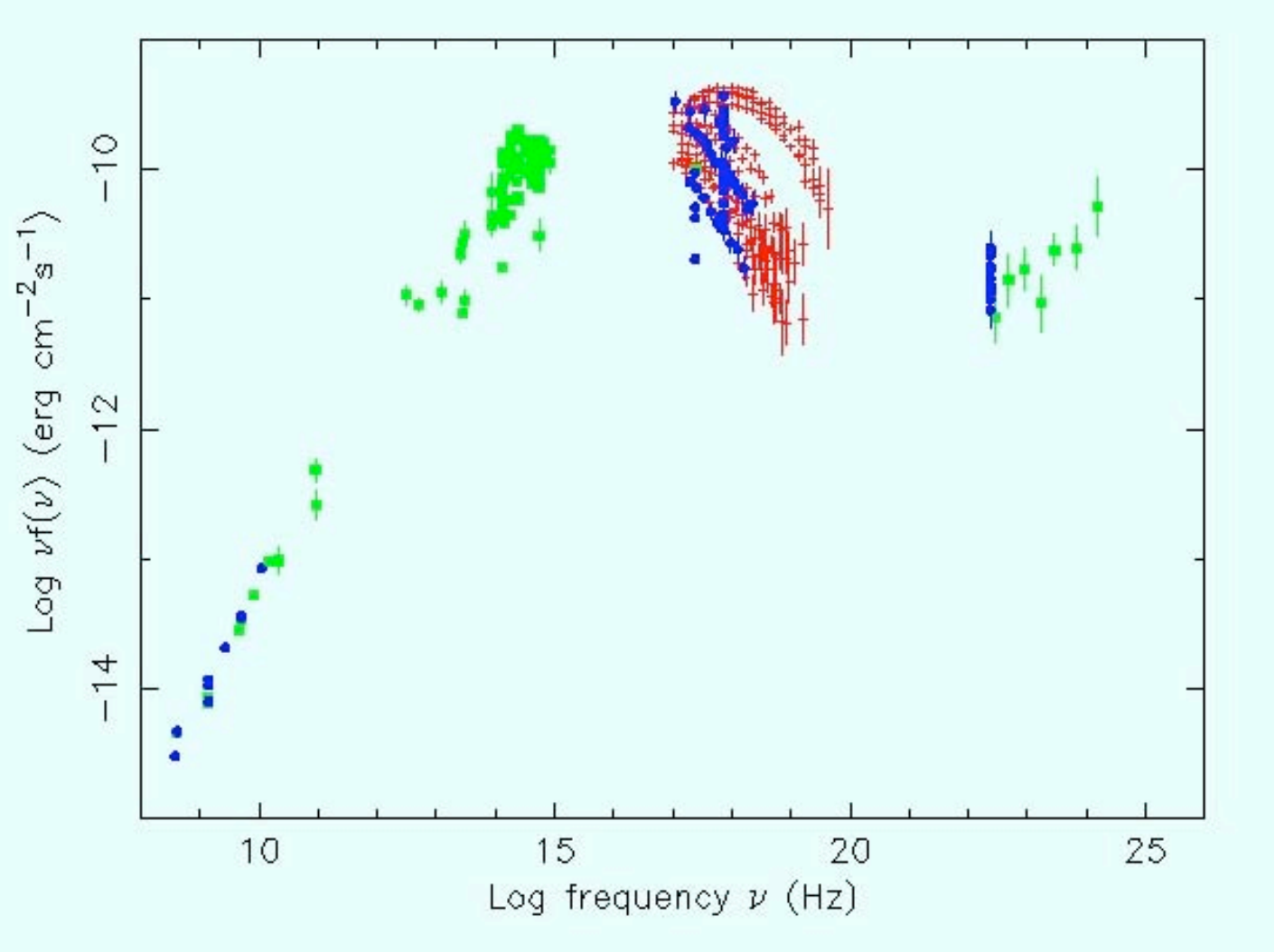
E. Cavazzuti, (ASDC), S. Colafrancesco, E. Massaro, P. Padovani.

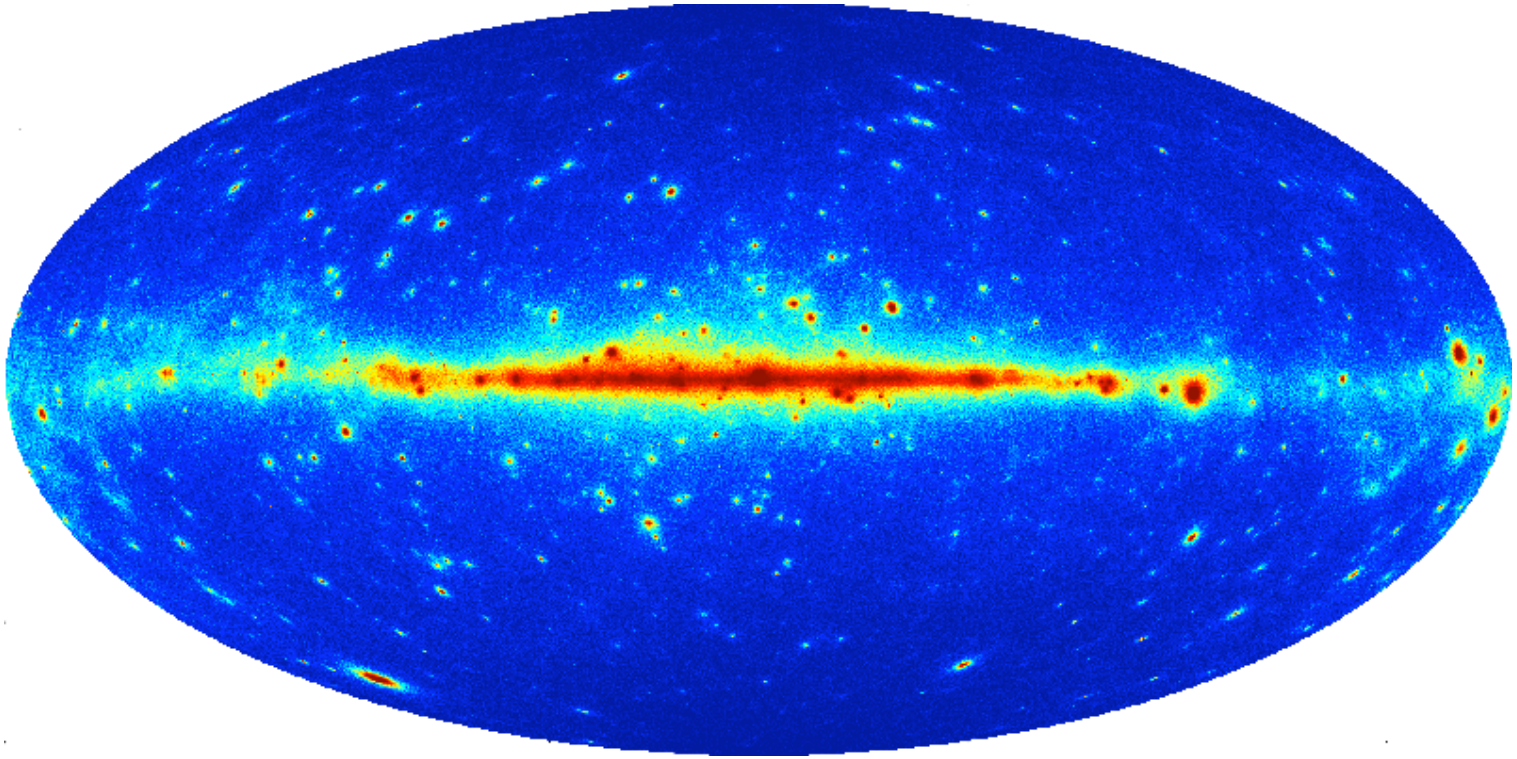
3C 279



MKN 421 : an HBL Blazar



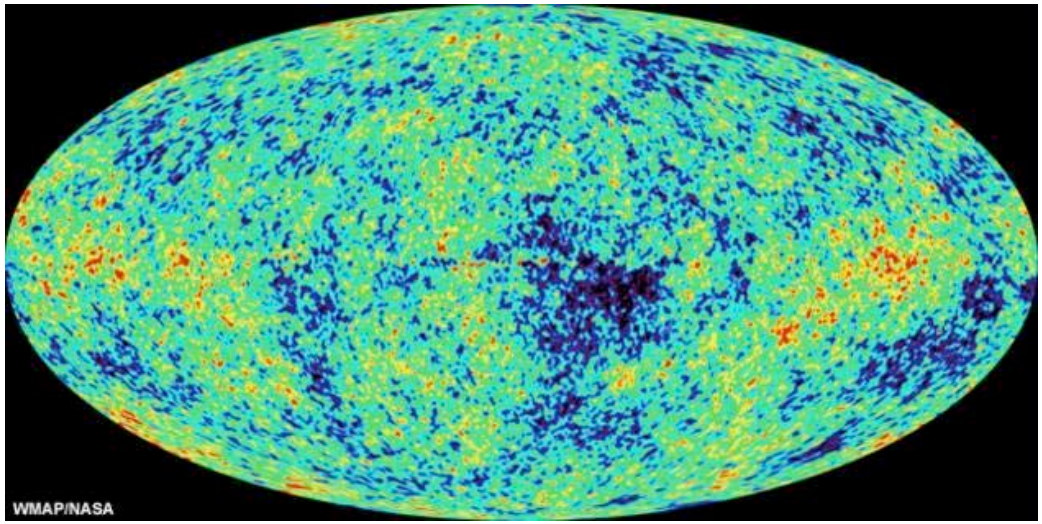
GLAST-LAT - 1 year simulation



- 3,000-10,000 detected blazars
- significant contribution to CGB from unresolved blazars with radio/μ-wave flux <~ 100 mJy

Blazars @ μ-wave frequencies: the 3-year WMAP data

WMAP CMB fluctuation map



Bright foreground source catalog

323 bright sources

- **194 FSRQs**
- **38 BL Lacs**
- **30 Radio galaxies**
- **15 Steep sp. QSO**
- **2 starburst galaxies**
- **2 planetary nebule**
- **41 unidentified**

The large majority of bright WMAP foreground sources are blazars or radio galaxies

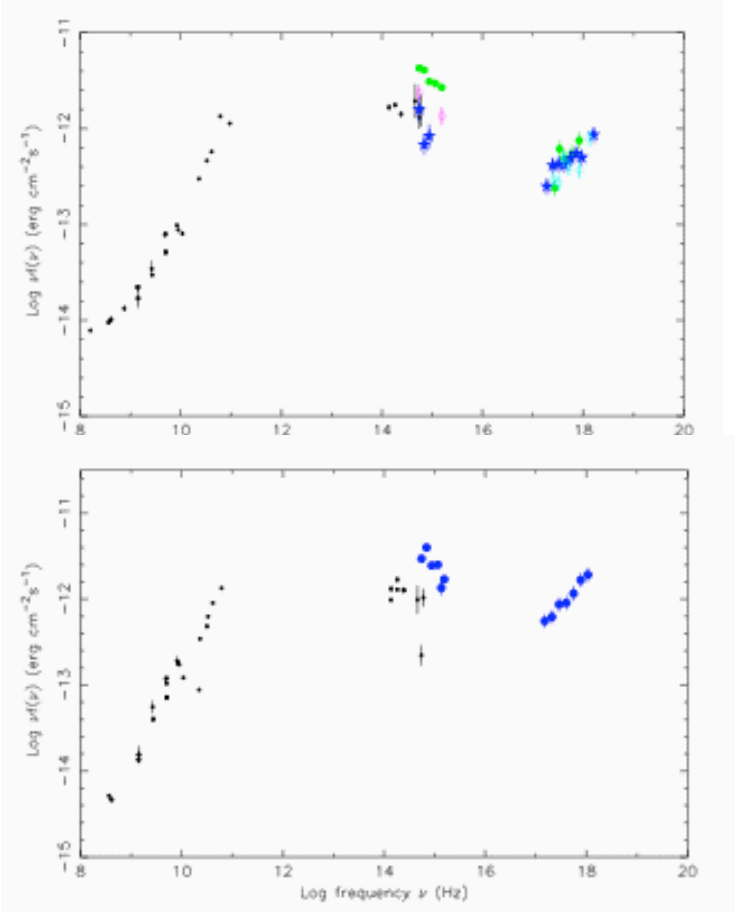
Planck will be in a vey similar situation to that of GLAST - LAT (thousands of deteced blazars + contribution to unresolved flux).

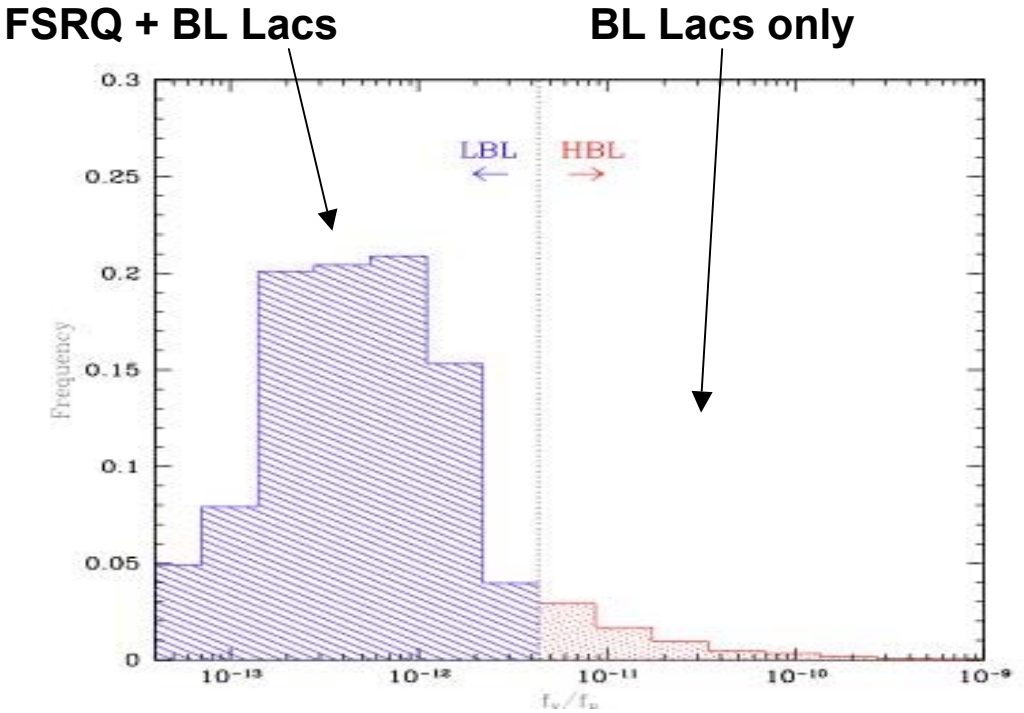
Swift detection of all previously undetected blazars in a micro-wave flux-limited sample of WMAP foreground sources

P. Giommi[1,2], M. Capalbi[1], E. Cavazzuti[1,2], S. Colafrancesco[3], A. Cucchiara[4], A. Falcone[4], J. Kennea[4], R. Nesci[5], M. Perri[1], G. Tagliaferri[6], A. Tramacere[5], G. Tosti[7], A. J. Blustin[8], G. Branduardi-Raymont[8], D. N. Burrows[4], G. Chincarini[6], A. J. Dean[9], N. Gehrels[10], H. Krimm[10], F. Marshall[10], A. M. Parsons[10], B. Zhang[11]

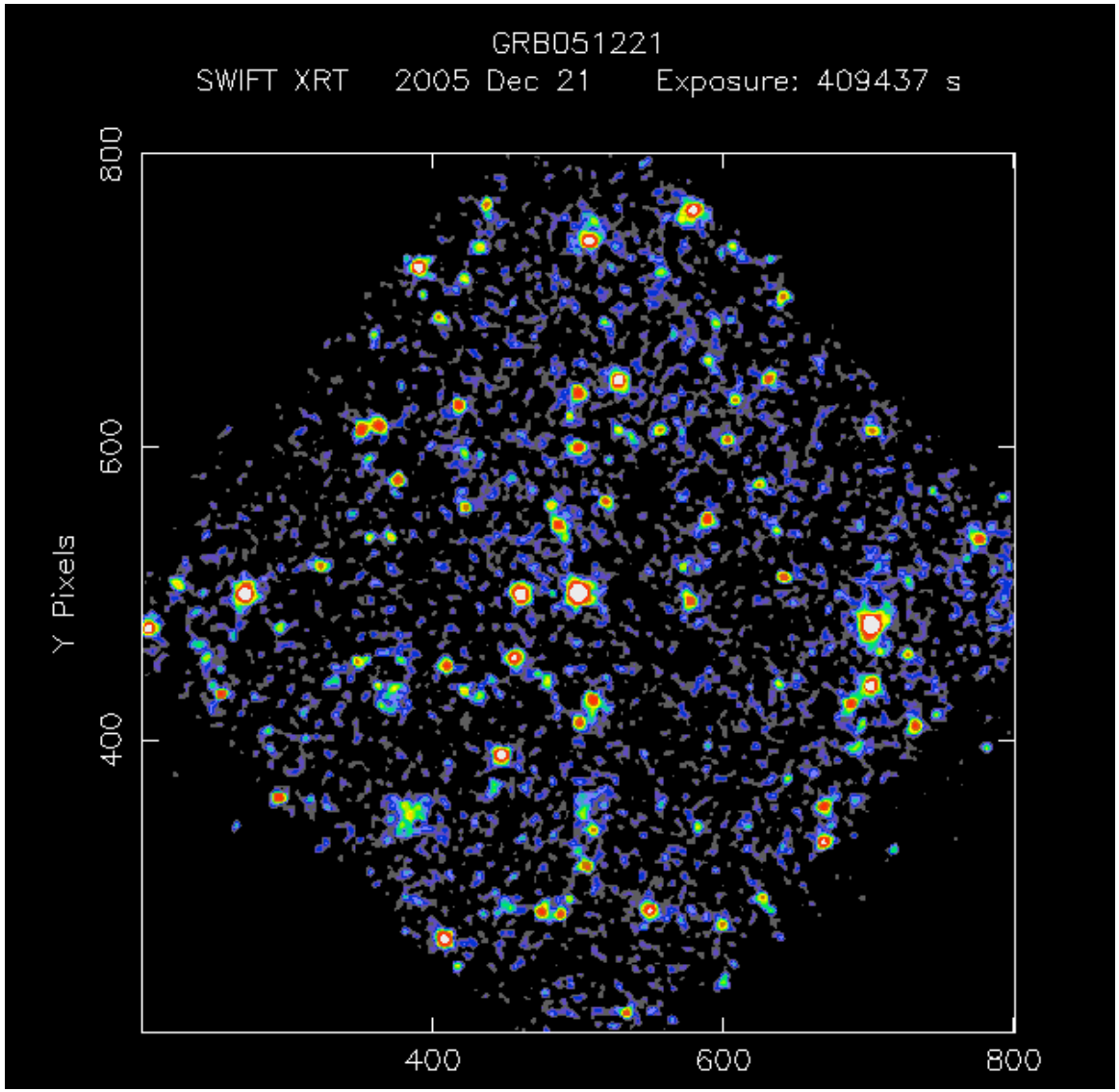
2007 A&A, in press

All microwave selected blazars are X-ray sources.

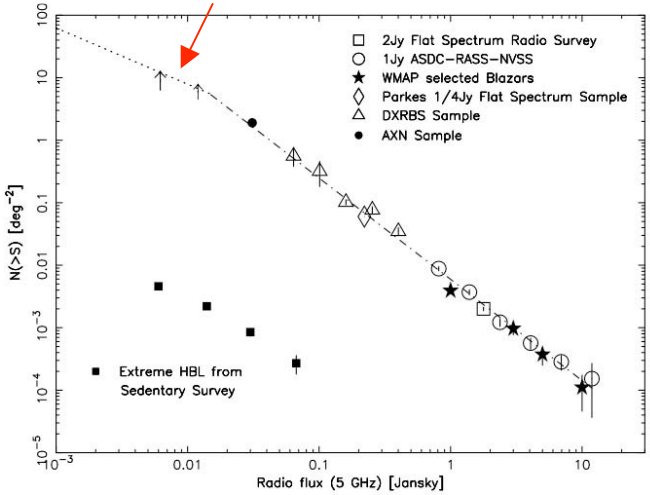




Swift XRT serendipitous sources in GRBs pointigs : the "*perfect*" serendipitous survey



~1 blazar/field expected with radio flux > 10 mJy!



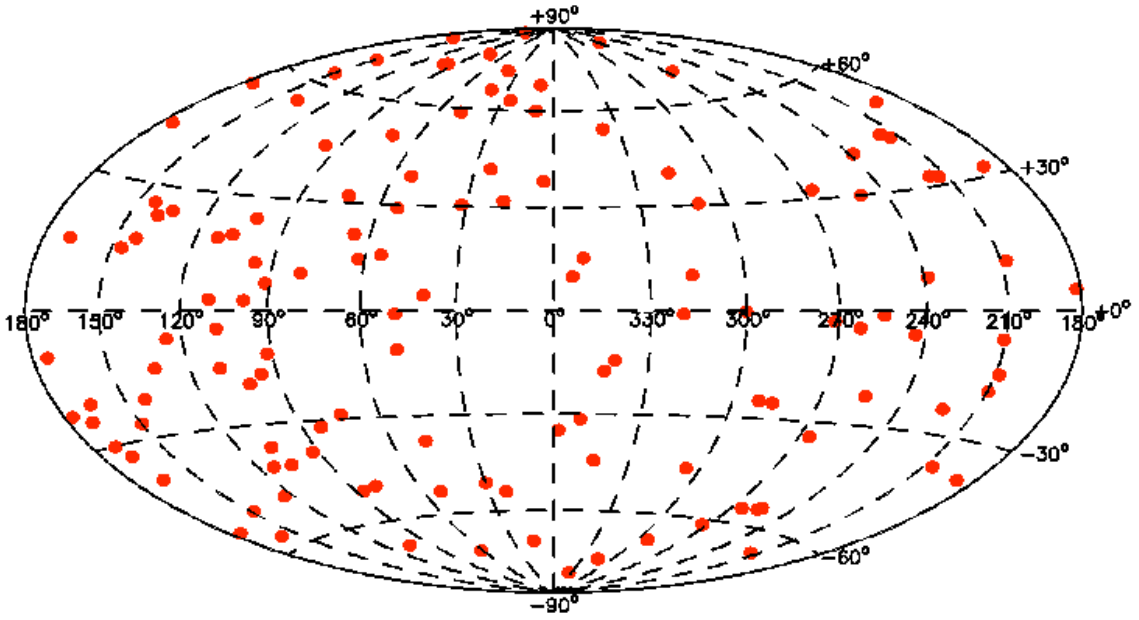
Swift XRT serendipitous survey in GRB deep fields:
status as of end of January 2007

130 deep (4×10^4-6×10^5 seconds) GRB exposures analyzed

~11,000 sources detected with positional uncertainty of 4-6 arscecs.

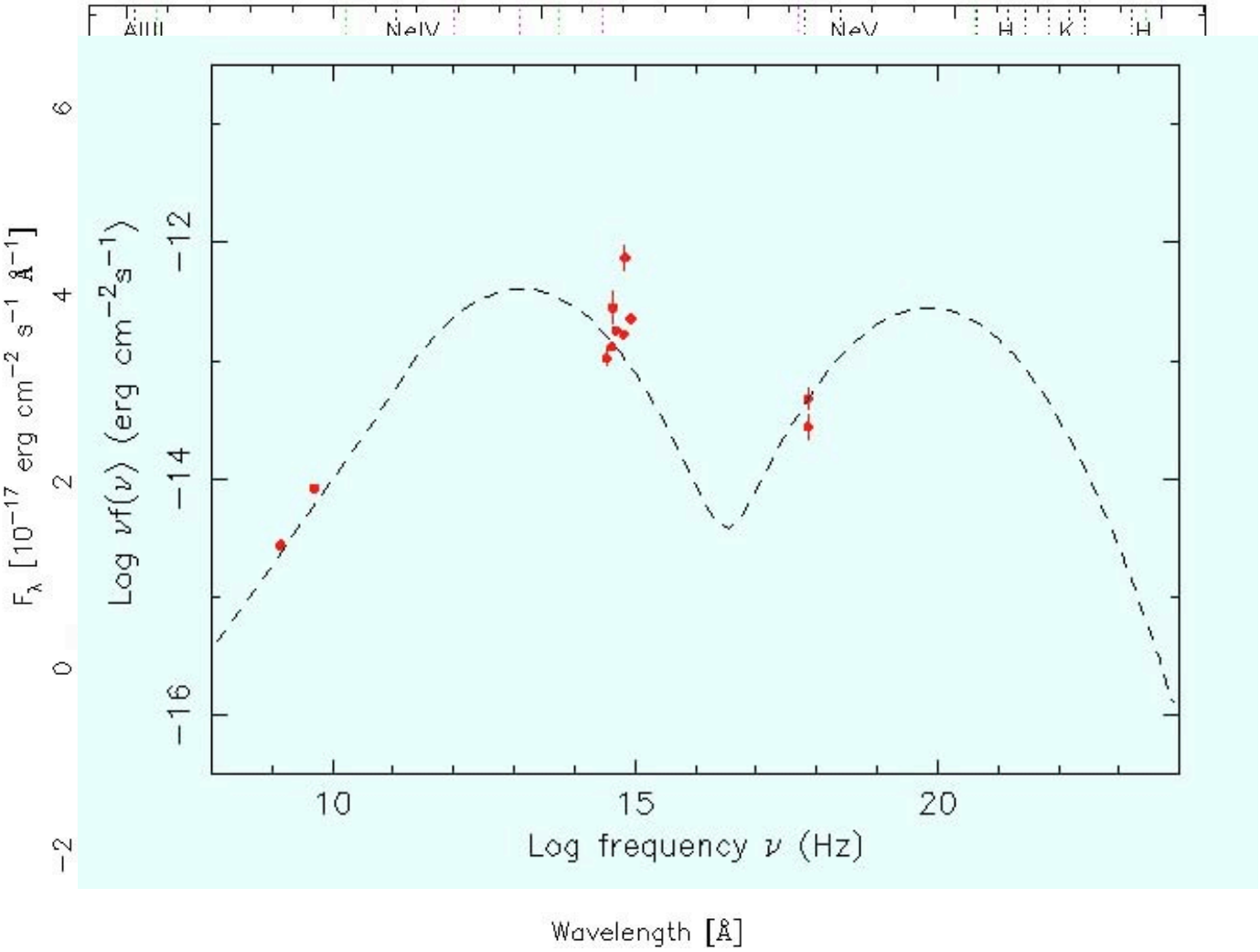
90 fields are at |bII| > 20 : ~8,000 sources

164 radio/X-ray matches (blazar candidates)



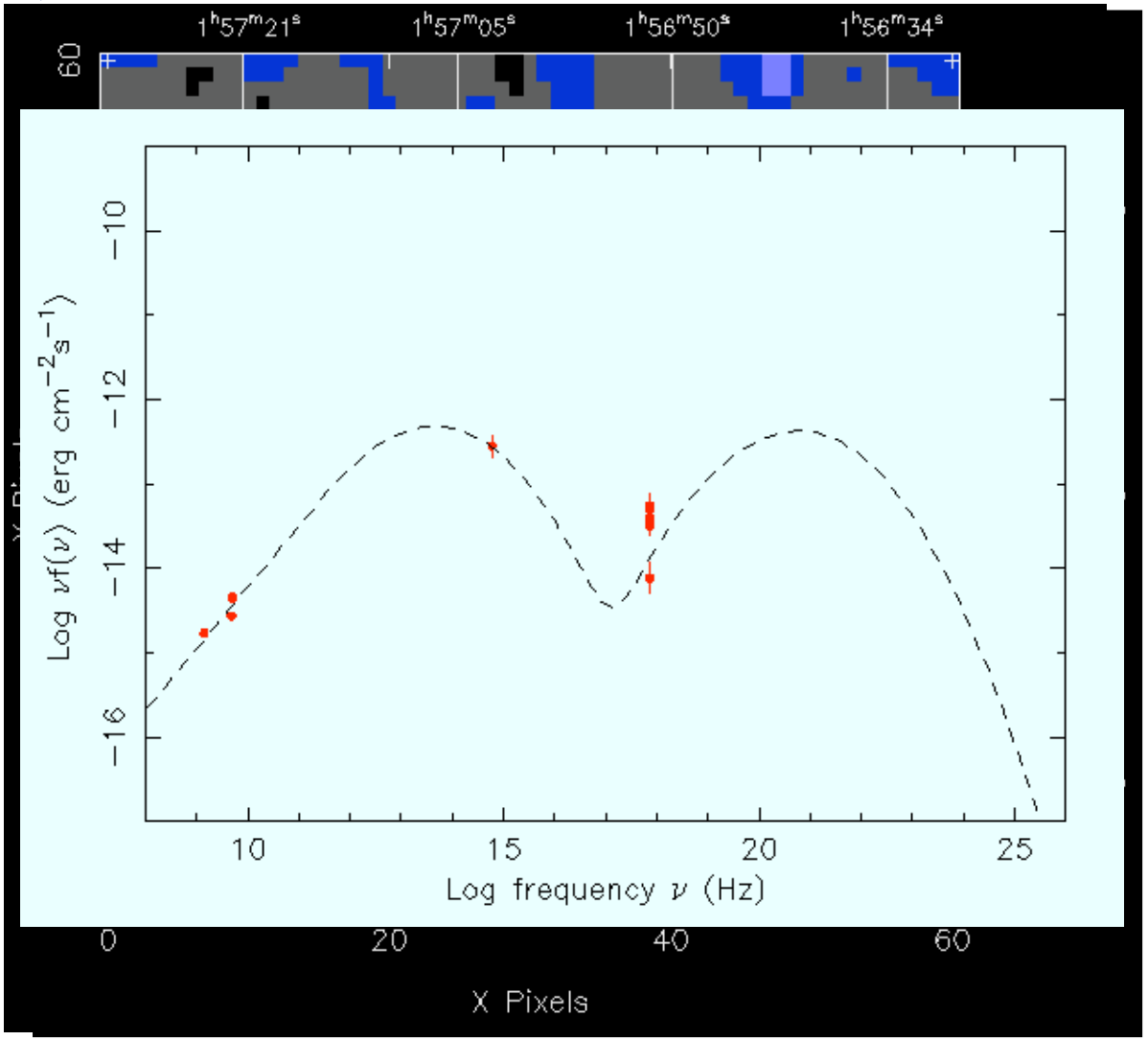
Swift J101724.4+432905: FSRQ, z=1.1735

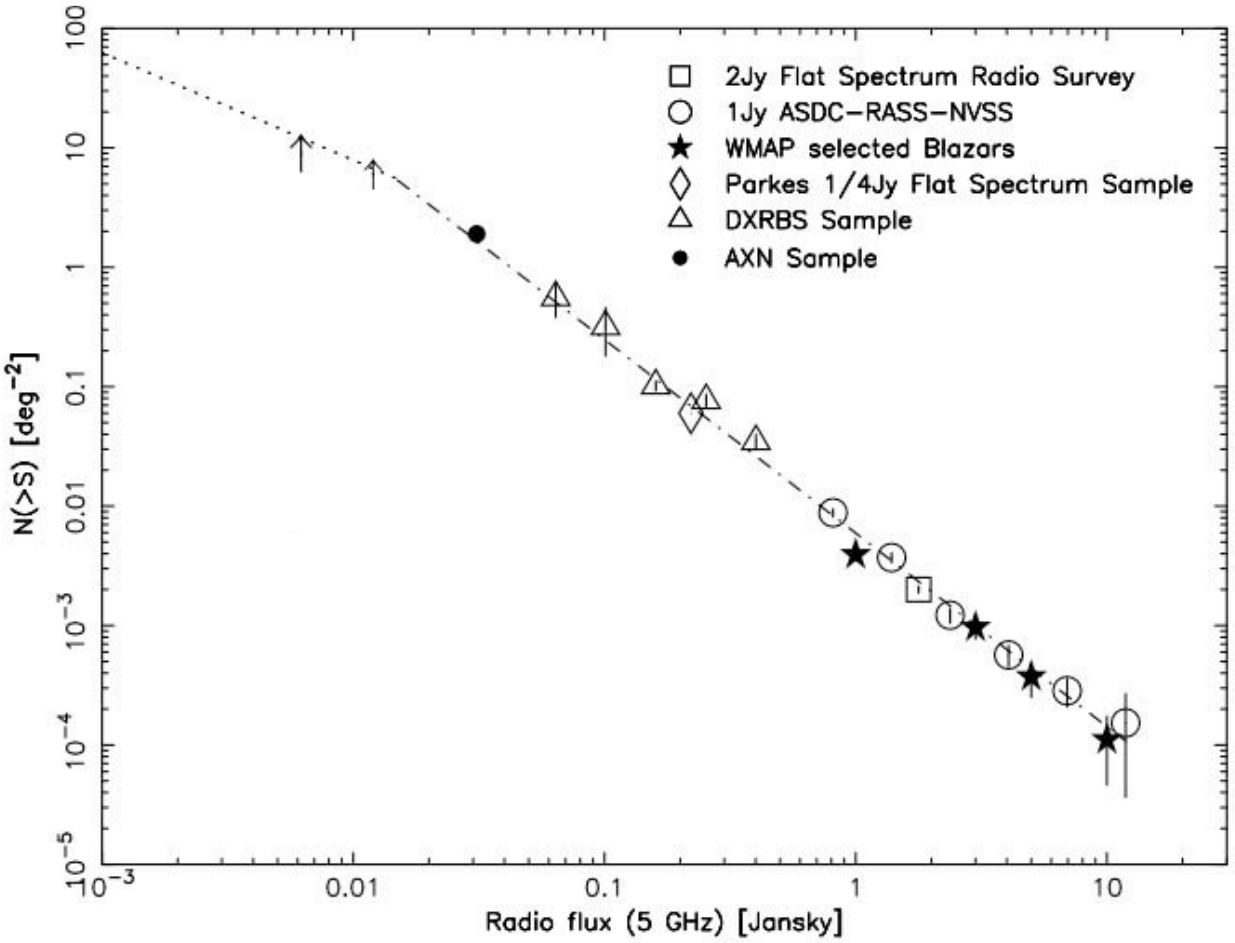
f_X ~6x10^{-14}erg/cm2/s, 197 mJy @ 1.4 GHz

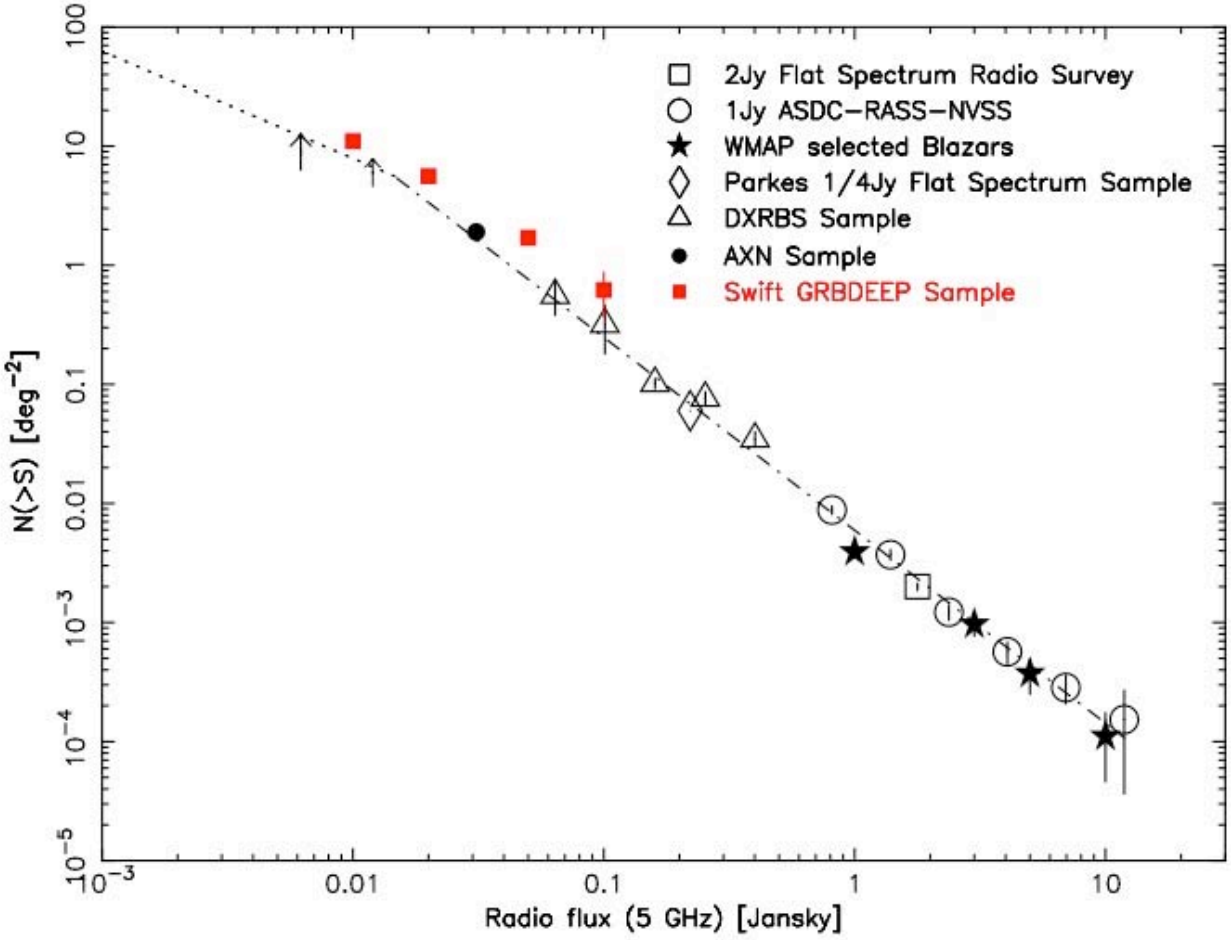


Swift J015700.6+085403 :

f_X ~5x10^{-14}erg/cm2/s, 122 mJy @ 1.4 GHz




2Jy Flat Spectrum Radio Survey
1Jy ASDC−RASS−NVSS
WMAP selected Blazars
Parkes 1/4Jy Flat Spectrum Sample
DXRBS Sample
AXN Sample
N(>S) [deg^{-2}]
Radio flux (5 GHz) [Jansky]
100
10
1
0.1
0.01
10^{-3}
10^{-4}
10^{-5}
10^{-3}
0.01
0.1
1
10


2Jy Flat Spectrum Radio Survey
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N(>S) [deg^{-2}]
Radio flux (5 GHz) [Jansky]
10^{-5}
10^{-4}
10^{-3}
0.01
0.1
1
10
100
10^{-3}
0.01
0.1
1
10

Blazars @ waves frequencies:

the 3-year WMAP data

Results of <V/Vm> test

(Ω_M=0.3, Ω_Λ=0.7)

Sample (No of objects)	<V/Vm>	Flux limit @41 GHz
FSRQ (145)	0.63 +/-0.023	1000 mJy
BL Lacs (27)	0.62 +/-0.055	1000 mJy

The Deep X-Ray Radio Blazar Survey (DXRBS). III. Radio Number Counts, Evolutionary Properties, and Luminosity Function of Blazars

Padovani, Giommi, Landt & Perlman, 2007, submitted

Table 1. Complete sample composition.

Class	Total	Newly identified	Previously known	No redshift
FSRQ	129	79	50	0
BL Lacs	24	15	9	7
BL Lacs, $\alpha_r > 0.5$	7	6	1	0
SSRQ[a]	33	24	9	0
Radio Galaxies[a]	17	9	8	0
Unidentified	16	16		16
Unidentified, $\alpha_r > 0.5$	6	6		6

[a]The SSRQ and radio galaxies samples are obviously incomplete, as our radio spectral index cut excludes by definition the majority of these sources.

Radio flux limits
50-100 mJy
X-ray flux limits
2.e-14/5.e-13 0.3-2 keV

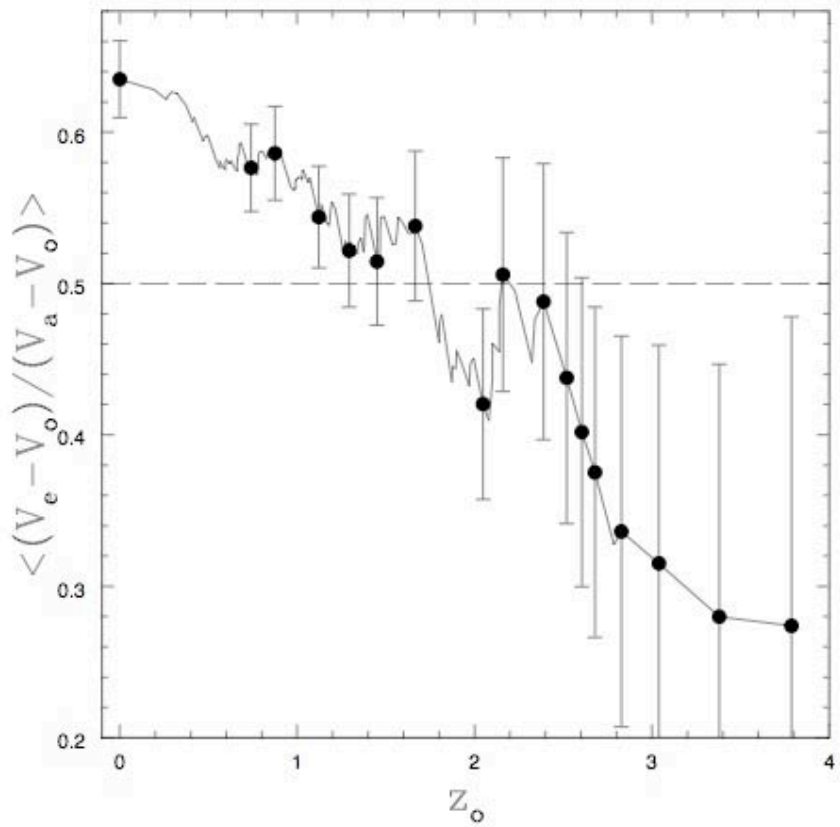
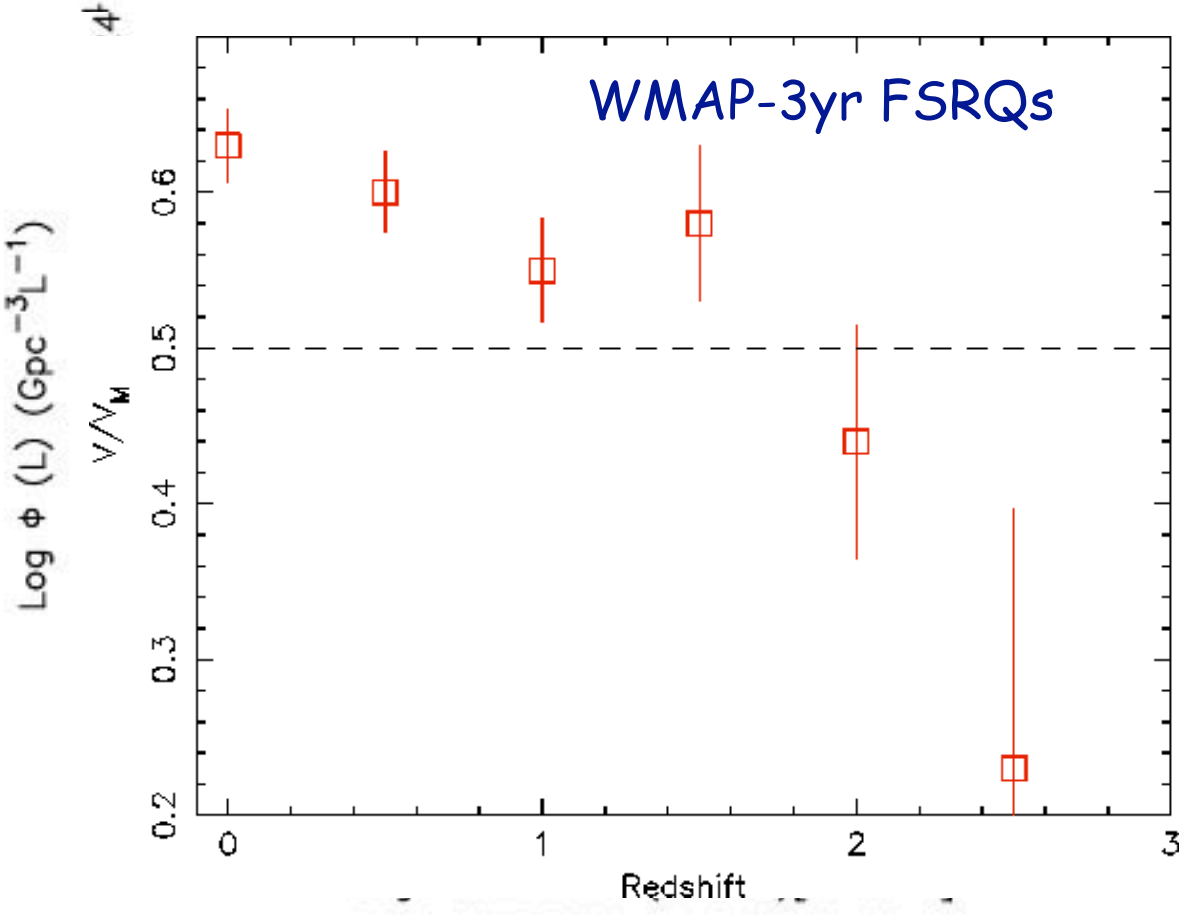
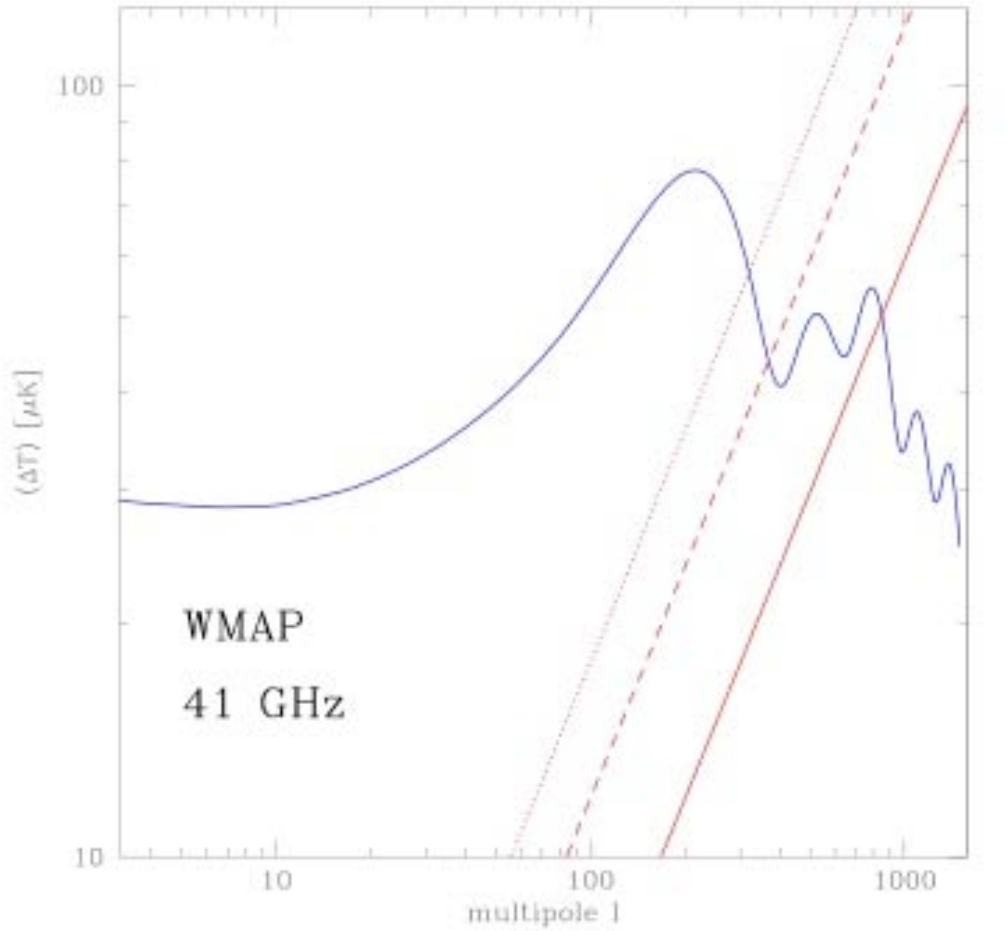


Fig. 7.— The banded $\langle V_e/V_a \rangle$ statistic, $\langle (V_e - V_o)/(V_a - V_o) \rangle$ versus z_o for DXRBS FSRQ. The horizontal dashed line indicates the value of 0.5 expected under the null hypothesis of no evolution. The statistical error bars, given by $(12\ N)^{-0.5}$, where N is the number of objects in the subsample with $z > z_o$, are shown for selected redshifts.


WMAP-3yr FSRQs
Log Φ (L) (Gpc^{-3}L^{-1})
V/V$_M$
0.2
0.3
0.4
0.5
0.6
0
1
2
3
Redshift

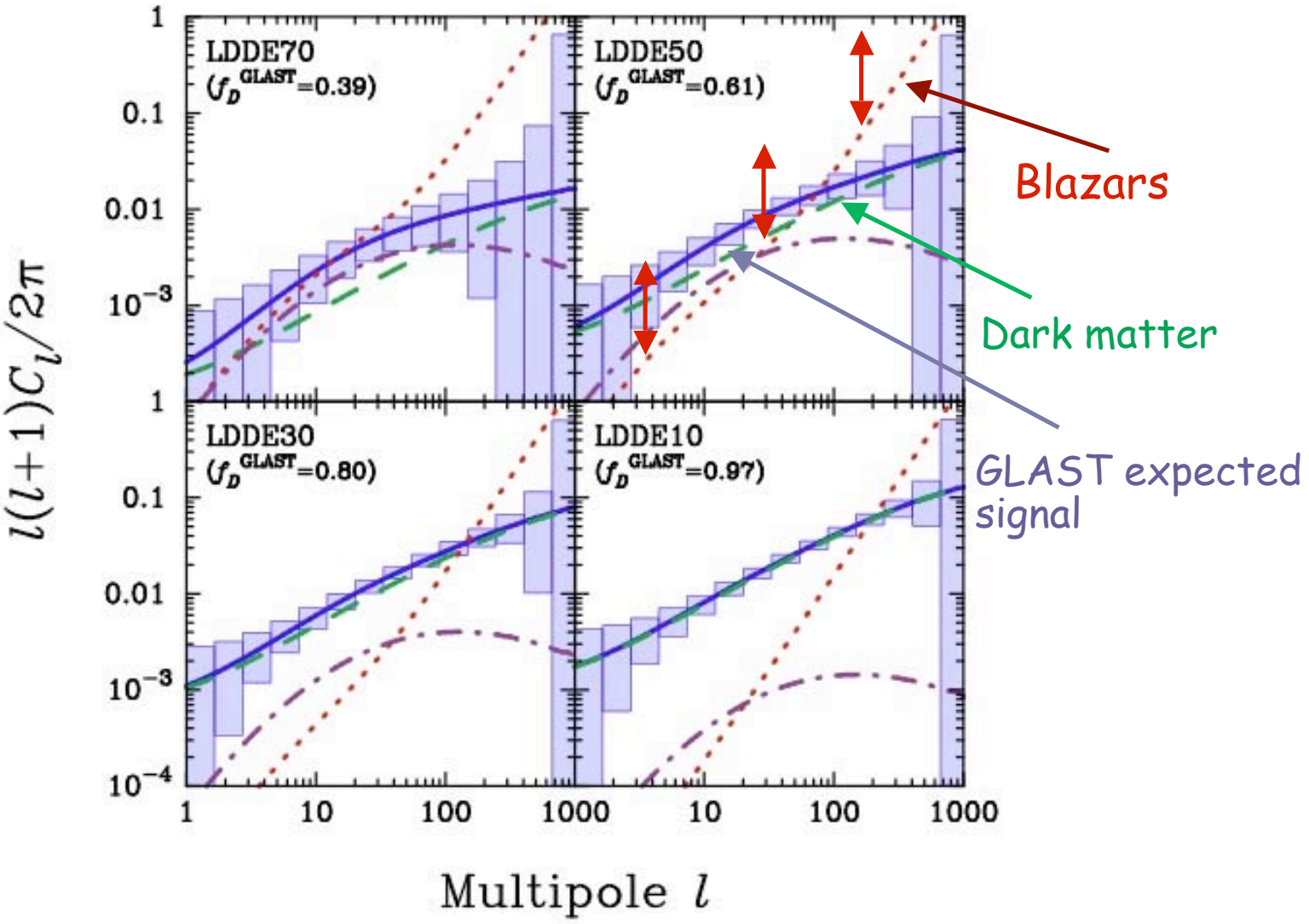
CMB spectrum contamination

Giommi & Colafrancesco 2004 A&A 414,7, Giommi et al. 2006 A&A 445, 843



Dark matter-blazar angular power spectrum

Ando Komatsu Narumoto & Totani 2007 Astro-ph/0612467,
Colafrancesco & Giommi 2007, in preparation.



Deep Blazars survey in Swift GRB fields
Conclusions and prospects

- ~200 Swift deep GRB fields available today (20 sq deg of sky)
  (300 at the end of 2007)
- 150-200 blazars in radio flux limited sample (f_{5GHz} = 10 mJy)
  ~ 400-500 blazars with radio flux down to ~ 1 mJy
- Extensive multi-frequency data available (in principle)
  (from GRB follow-up observations)

- Radio LogN-LogS to 10 mJy, radio LF + Cosmological evolution
- Volume-limited X-ray survey to z=0.5 for Lx > 5.e42 erg/s
- Tight constraints to microwave and gamma-ray backgrounds.