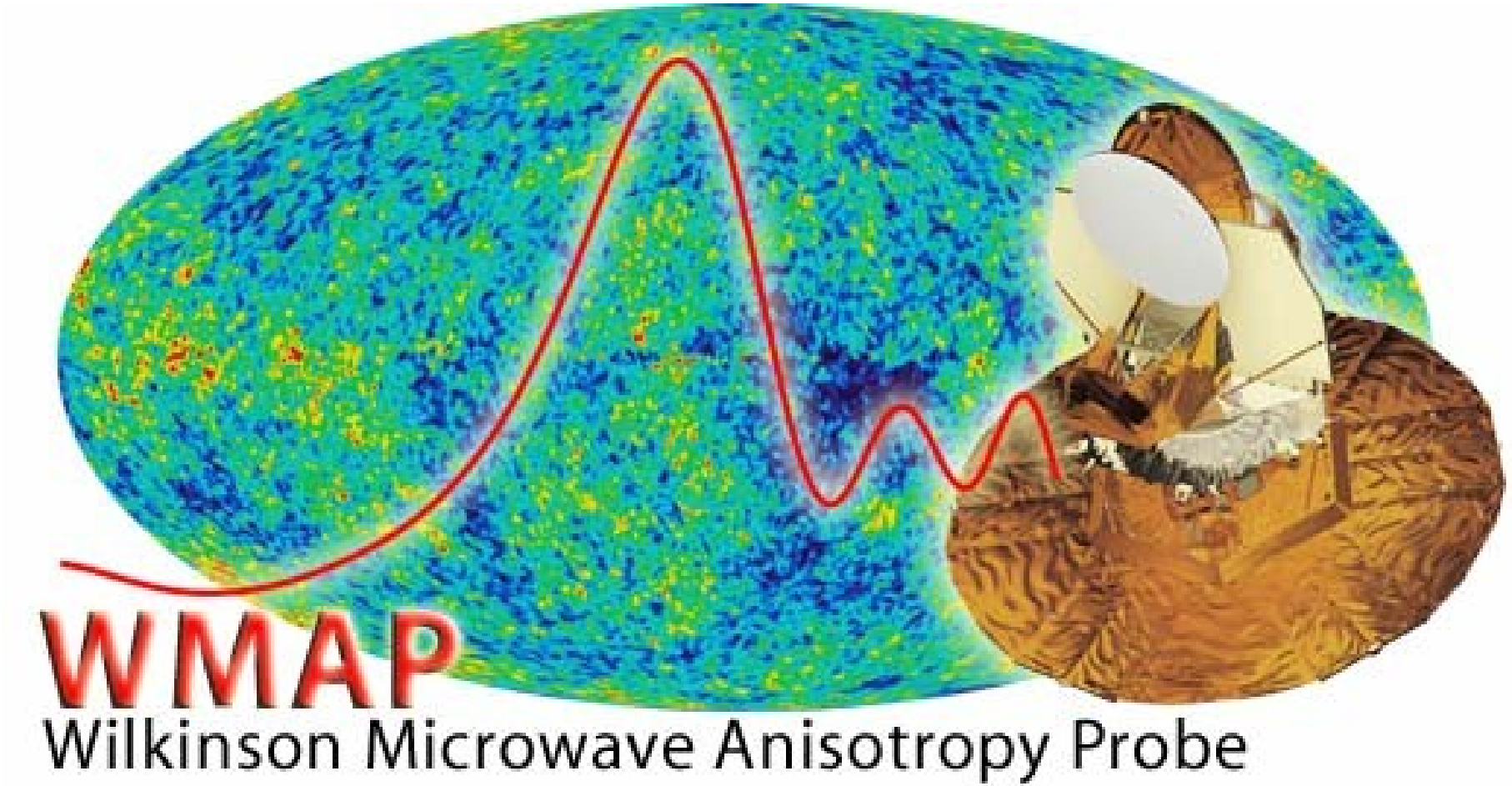
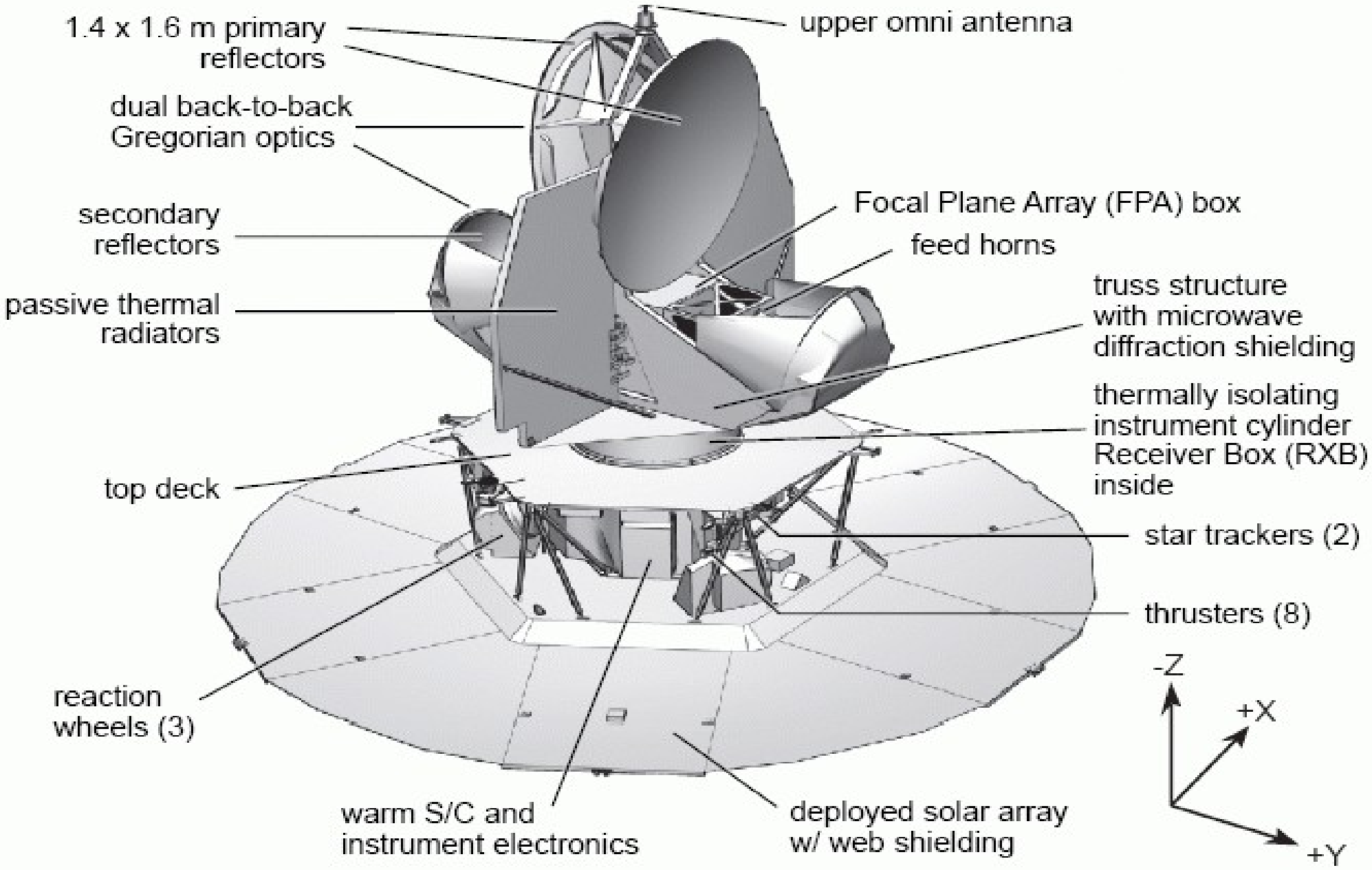
WMAP5 catalog sources

Sergei Trushkin

[Bul.SAO, v.55, 90 (2003) + 2006-2008]



WMAP design


1.4 x 1.6 m primary reflectors
upper omni antenna
dual back-to-back Gregorian optics
secondary reflectors
Focal Plane Array (FPA) box
feed horns
passive thermal radiators
truss structure with microwave diffraction shielding
thermally isolating instrument cylinder Receiver Box (RXB) inside
top deck
star trackers (2)
thrusters (8)
reaction wheels (3)
-Z
+X
+Y
warm S/C and instrument electronics
deployed solar array w/ web shielding

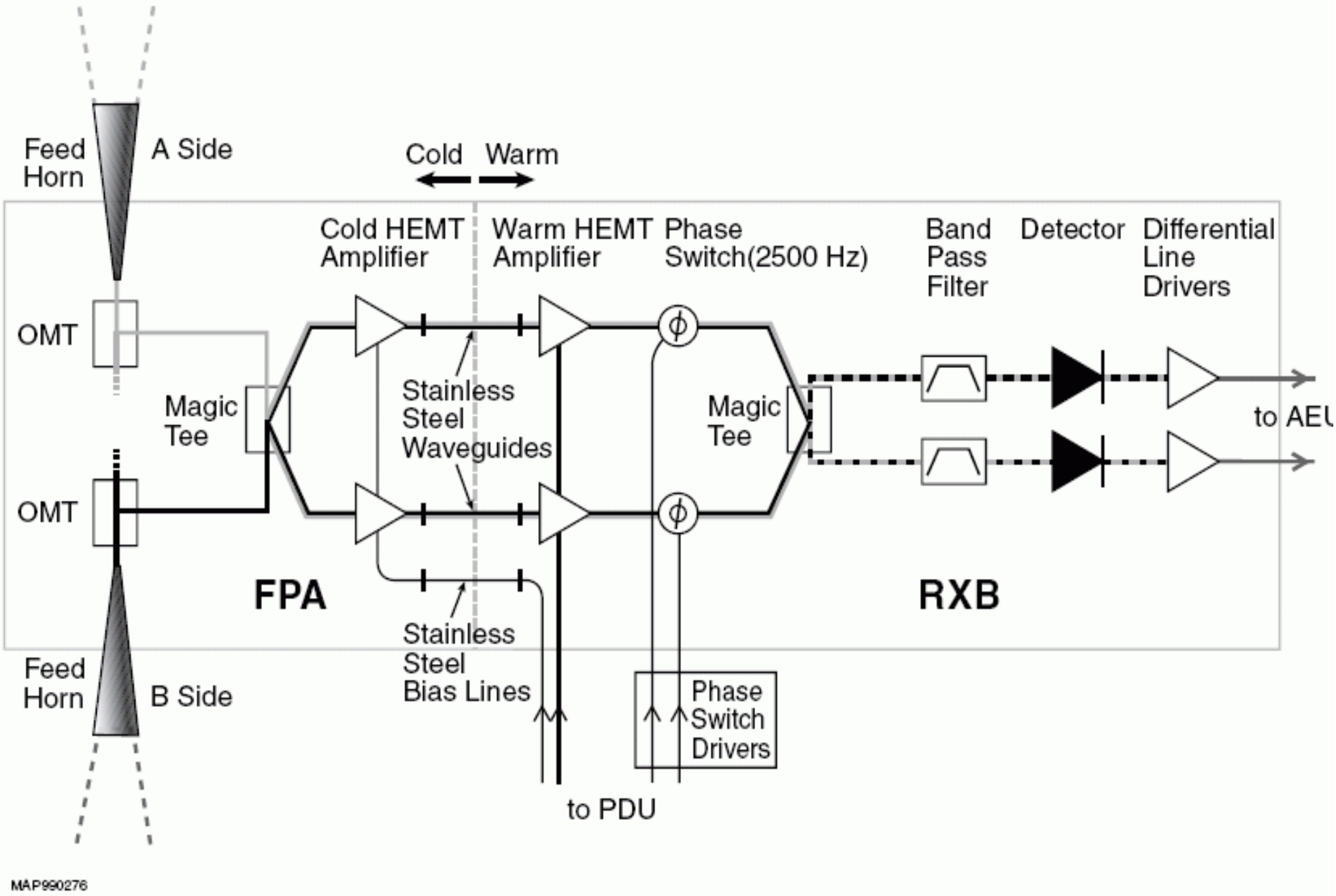
WMAP parameters

WMAP Mission Characteristics:

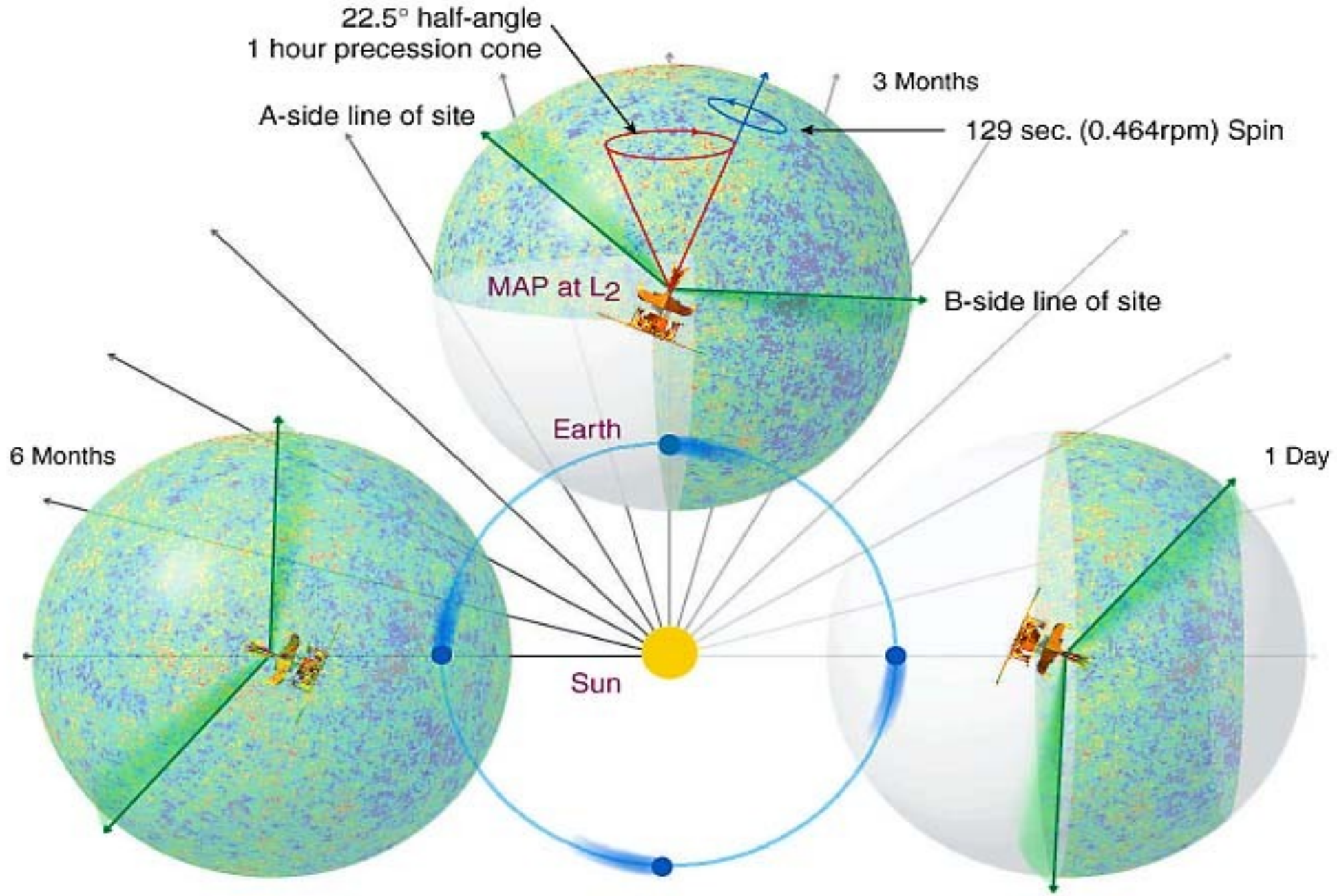
	K-Band[a]	Ka-Band[a]	Q-Band[a]	V-Band[a]	W-Band[a]
Wavelength (mm)[b]	13	9.1	7.3	4.9	3.2
Frequency (GHz)[b]	23	33	41	61	94
Bandwidth (GHz)[b, c]	5.5	7.0	8.3	14.0	20.5
Number of Differencing Assemblies	1	1	2	2	4
Number of Radiometers	2	2	4	4	8
Number of Channels	4	4	8	8	16
Beam size (deg)[b, d]	0.88	0.66	0.51	0.35	0.22
System temperature, *Tsys* (K)[b, e]	29	39	59	92	145
Sensitivity (mK sec$^{1/2}$)[b]	0.8	0.8	1.0	1.2	1.6

Sky coverage	Full sky
Optical system	Back-to-Back Gregorian, 1.4 x 1.6 m primaries
Radiometric system	differential polarization sensitive receivers
Detection	HEMT amplifiers
Radiometer Modulation	2.5 kHz phase switch
Spin Modulation	0.464 rpm = ~ 7.57 mHz spacecraft spin
precession Modulation	1 rev hr $^{-1}$ = ~ 0.3 mHz spacecraft precession
Calibration	In-flight: amplitude from dipole modulation, beam from Jupiter
Cooling system	passively cooled to ~ 90 K

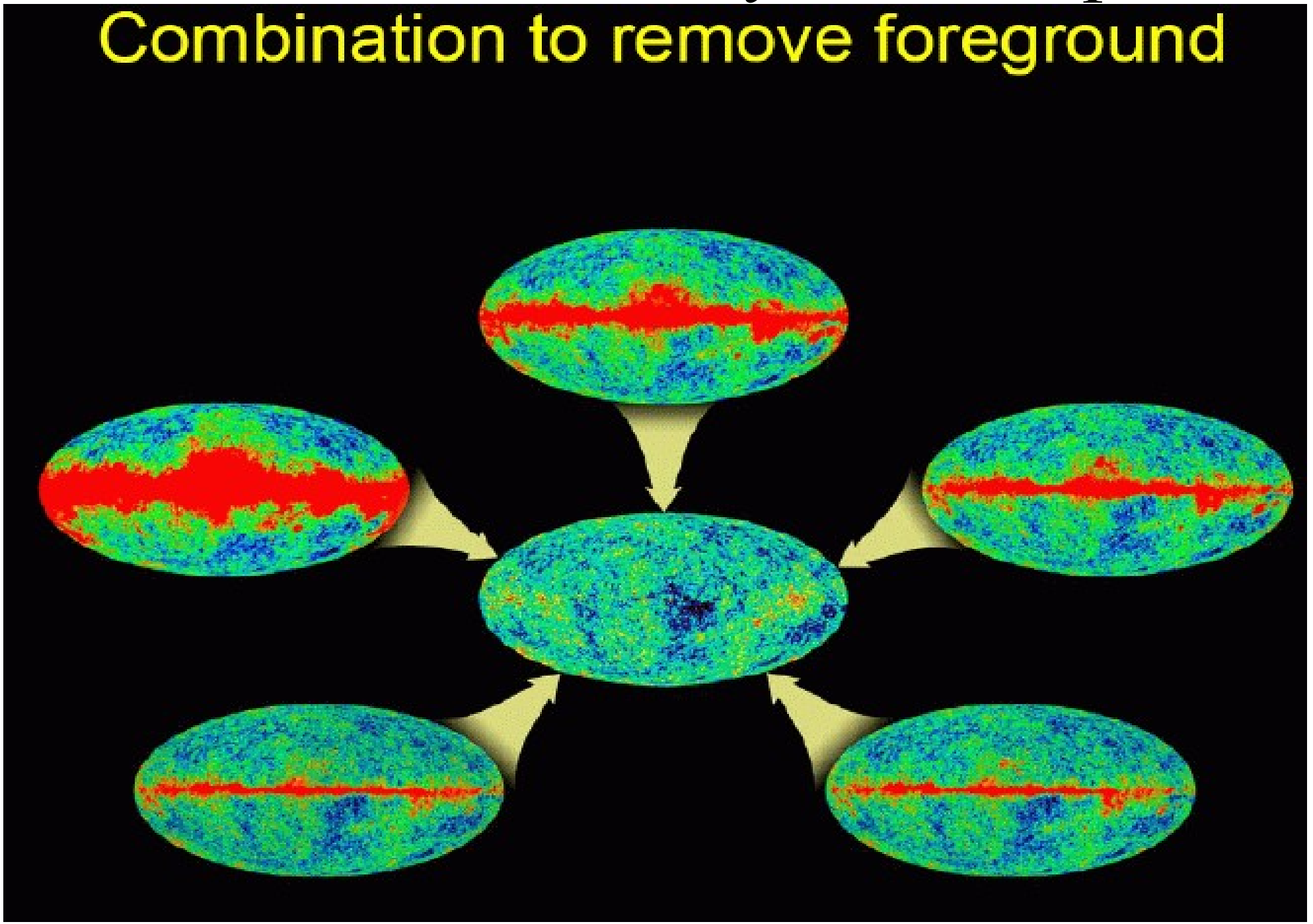
Radiometers



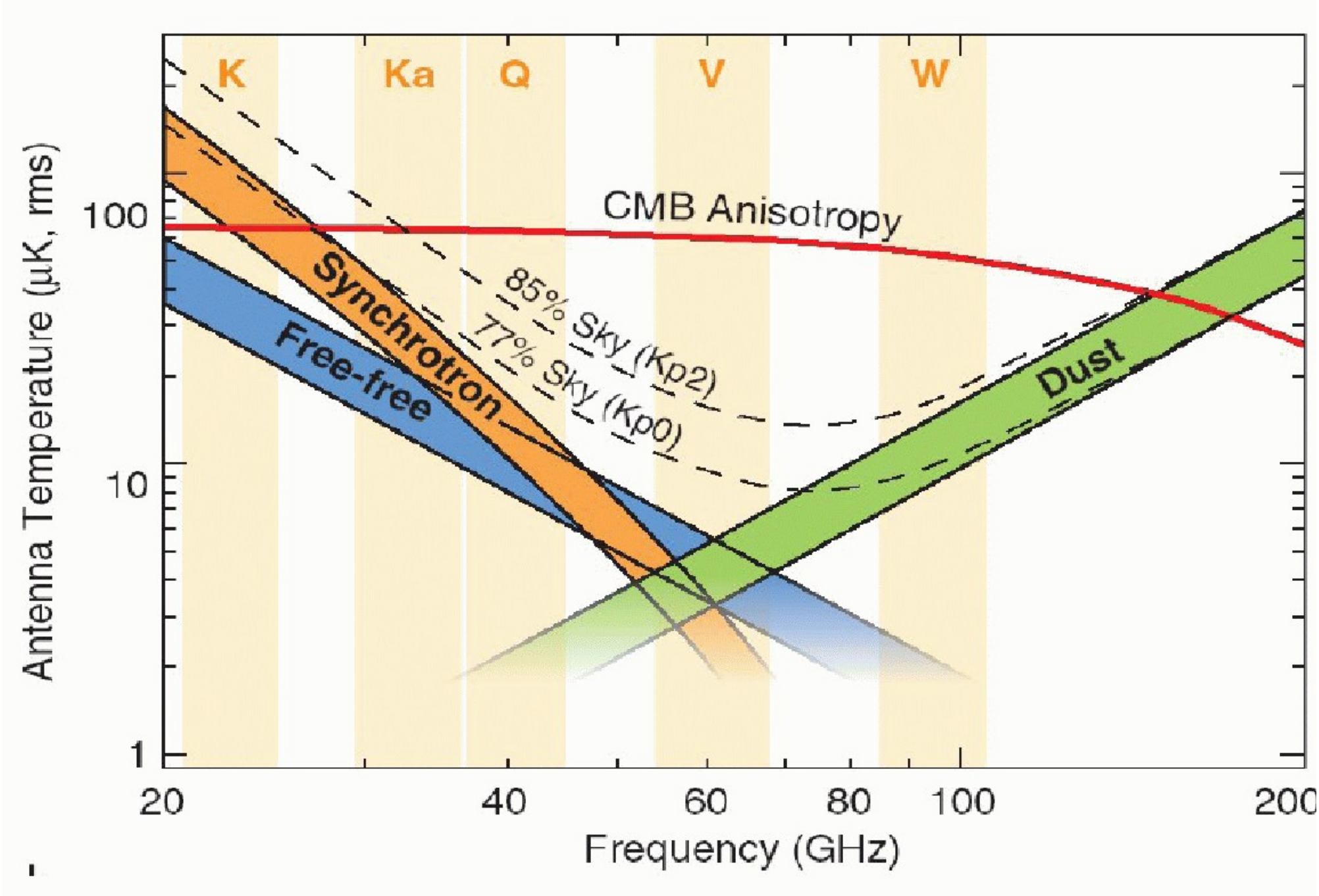
1 day = 30% of sky, 6 month = total sky



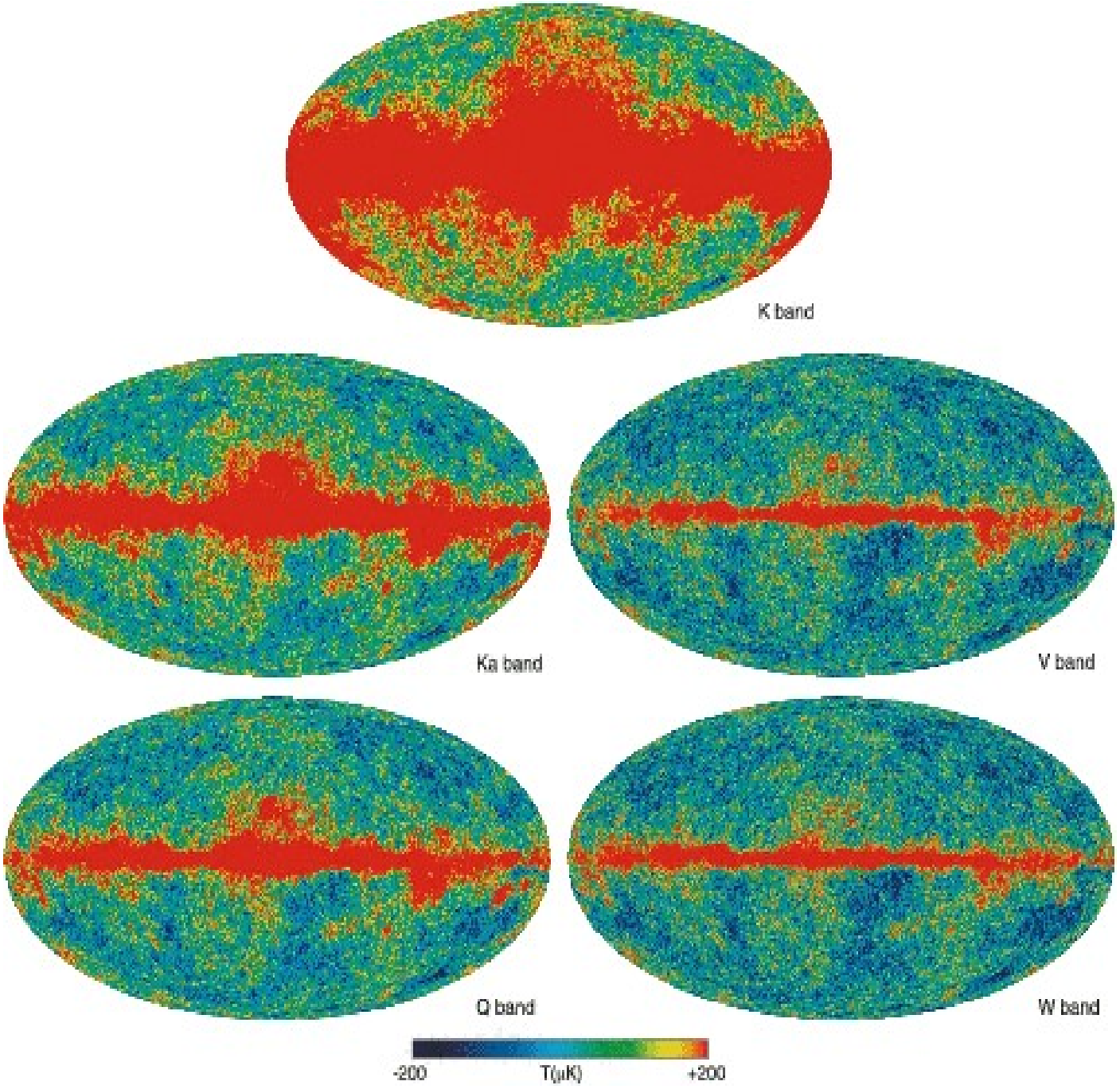
Пять диапазонов для удаления фонов



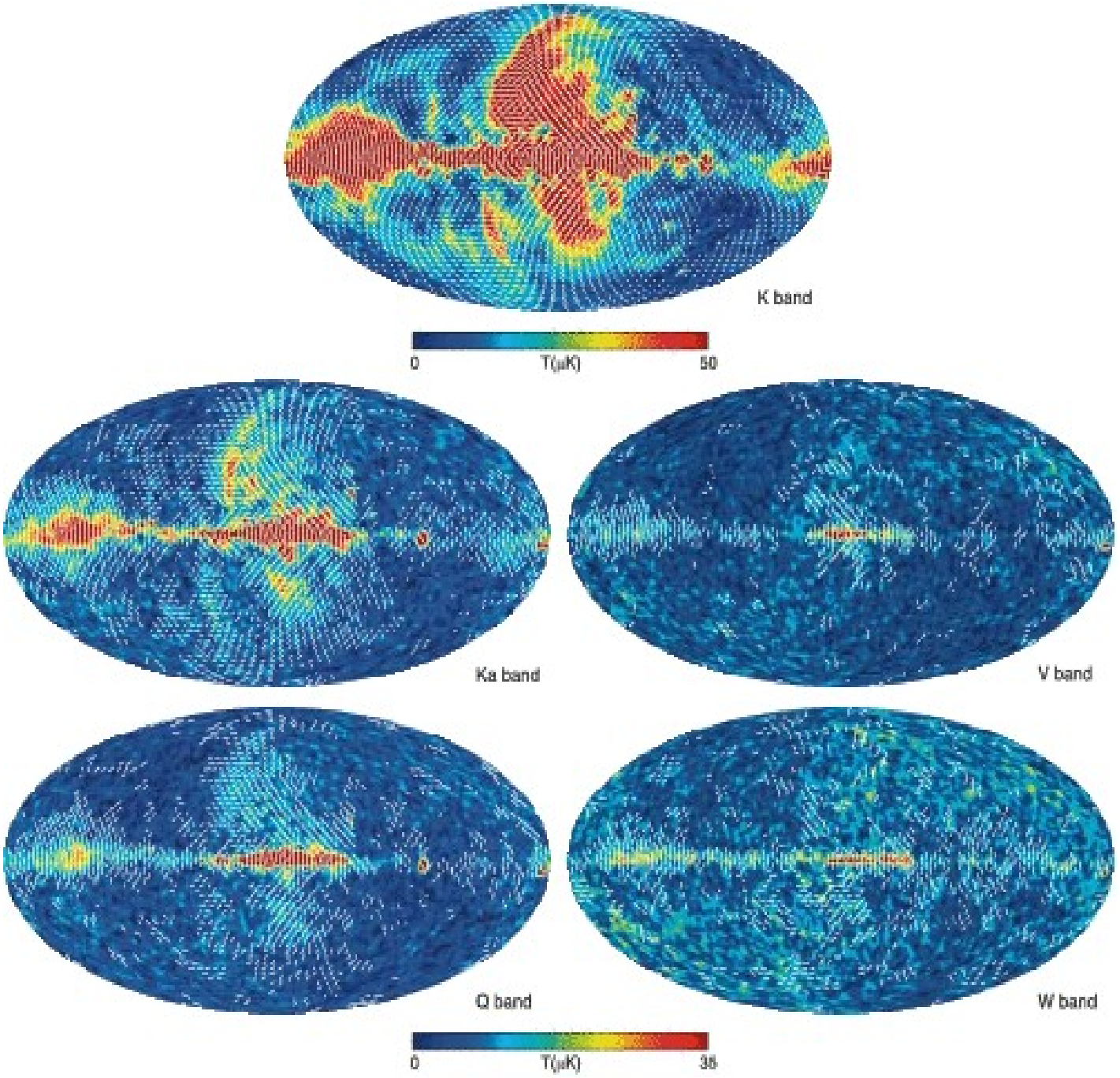
MW Synchrotron, f-f emission and dust



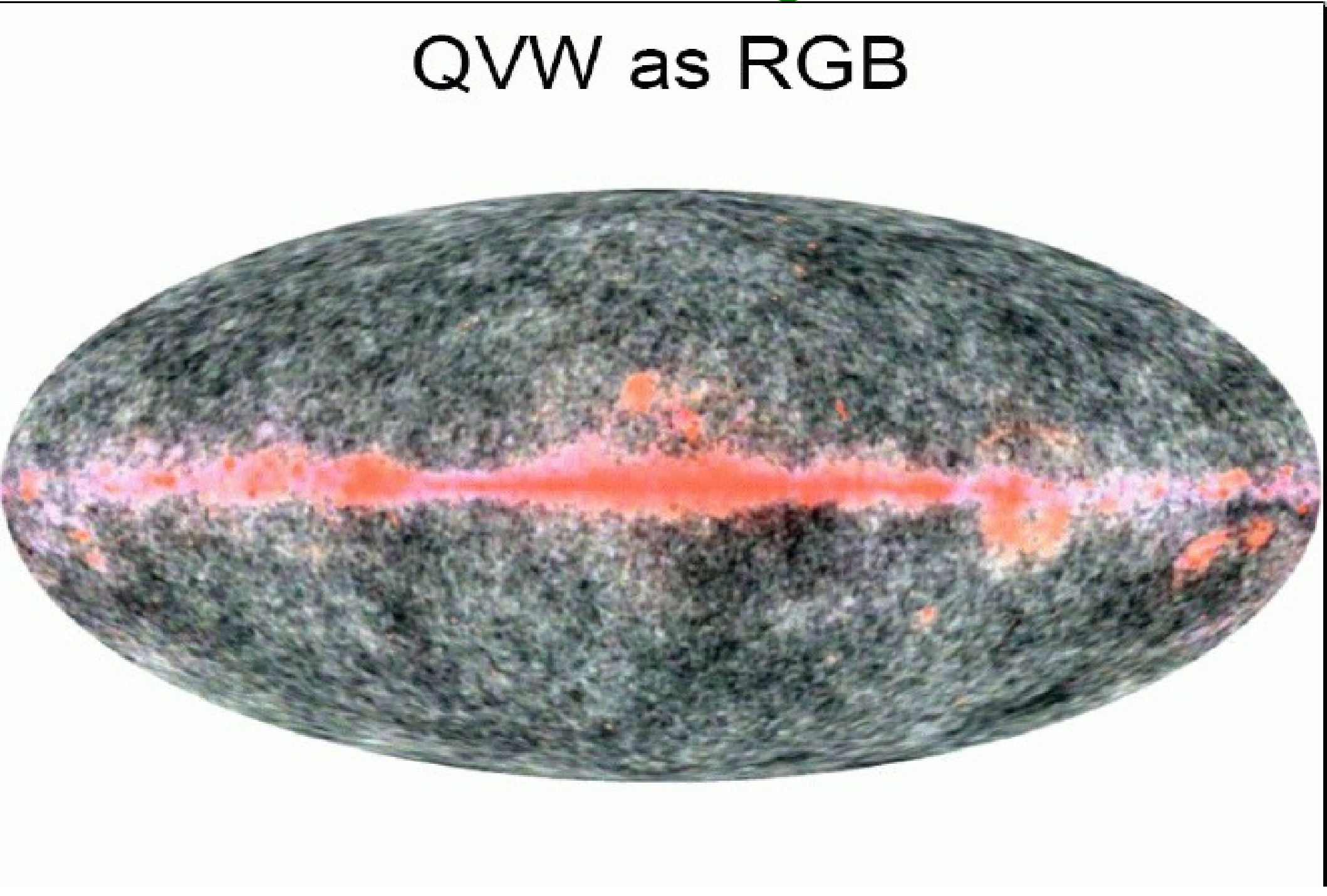
Five maps of intensity



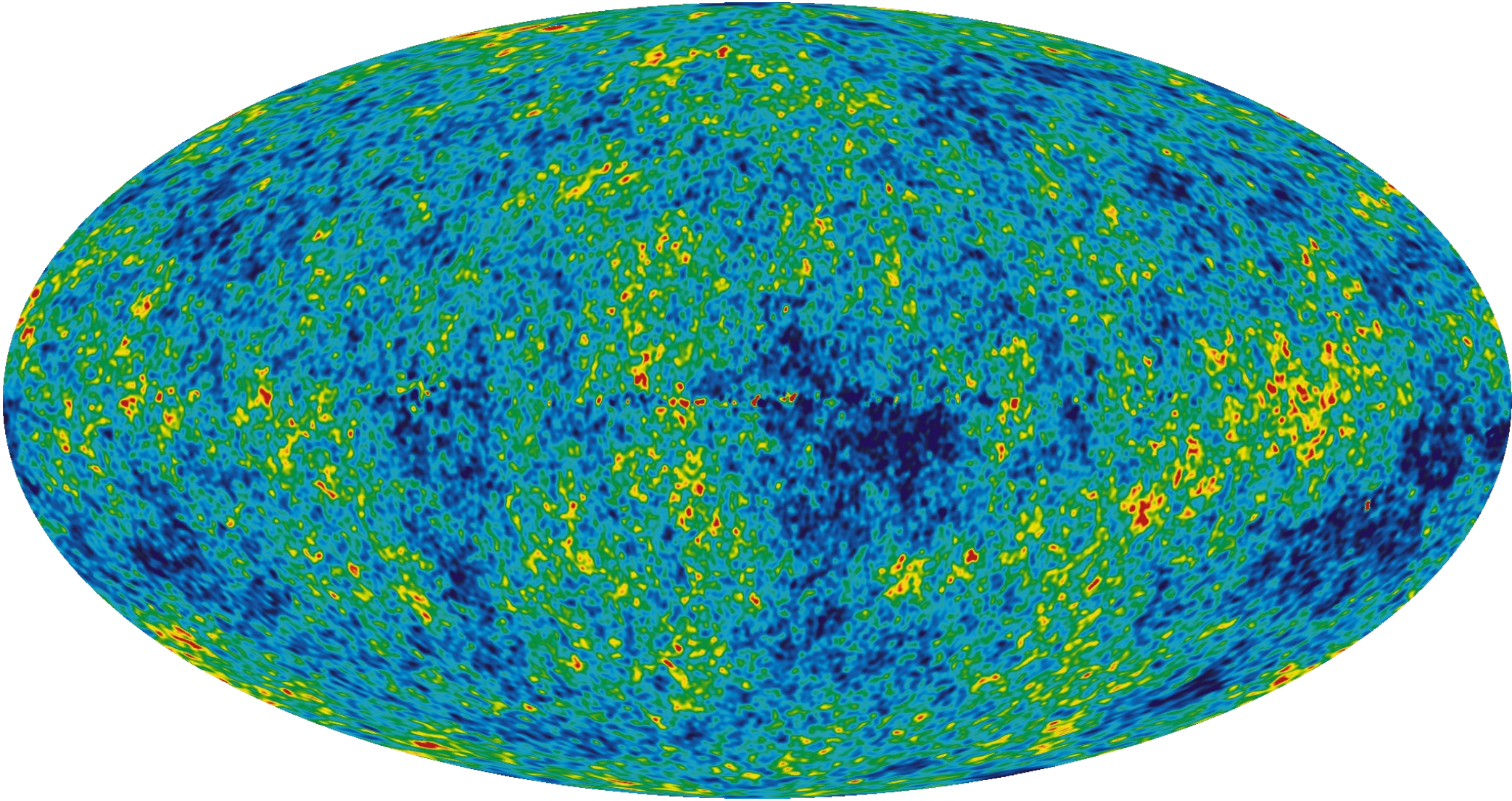
Linear polarization in five maps



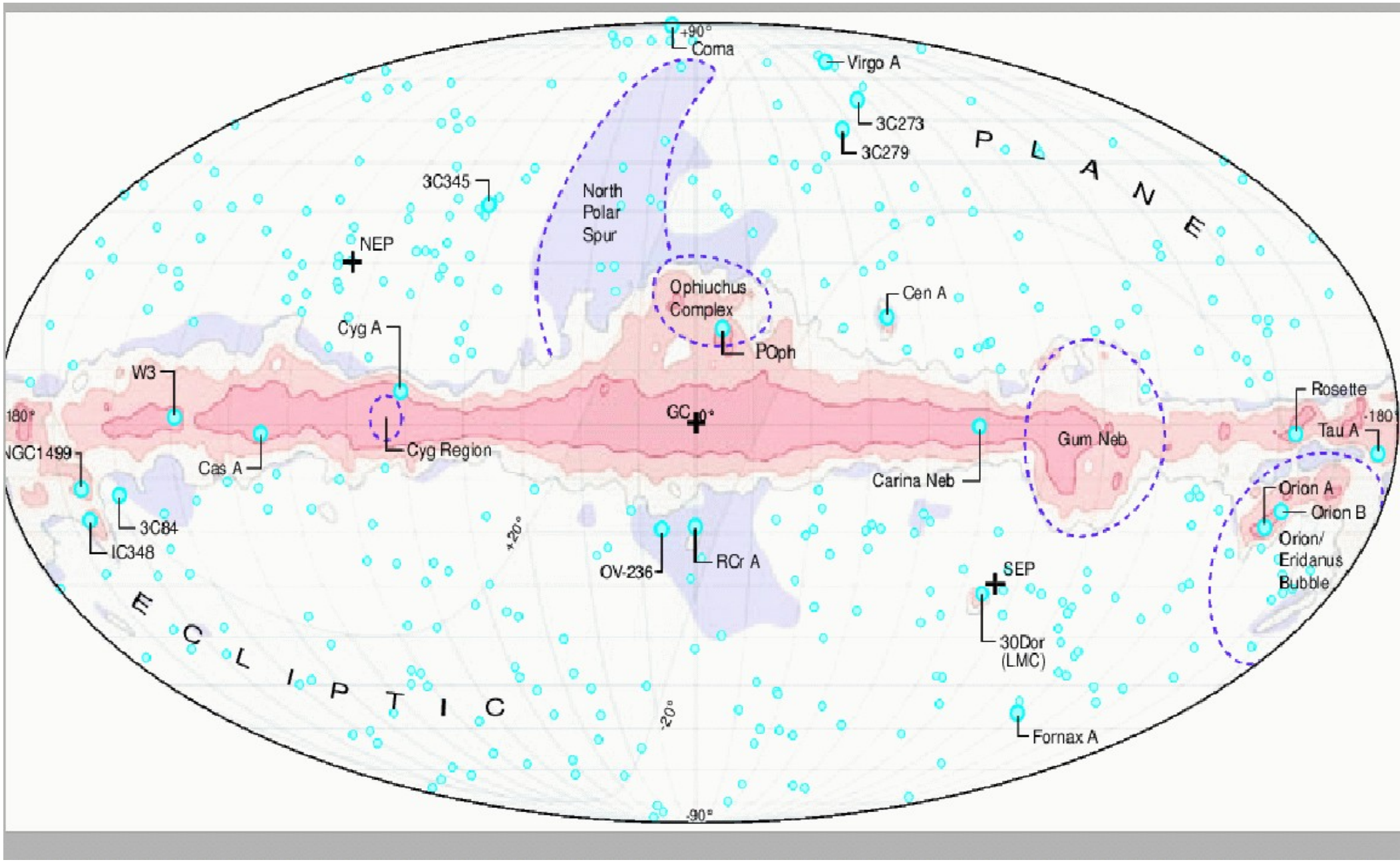
43, 61, 94 GHz as red, green and blue



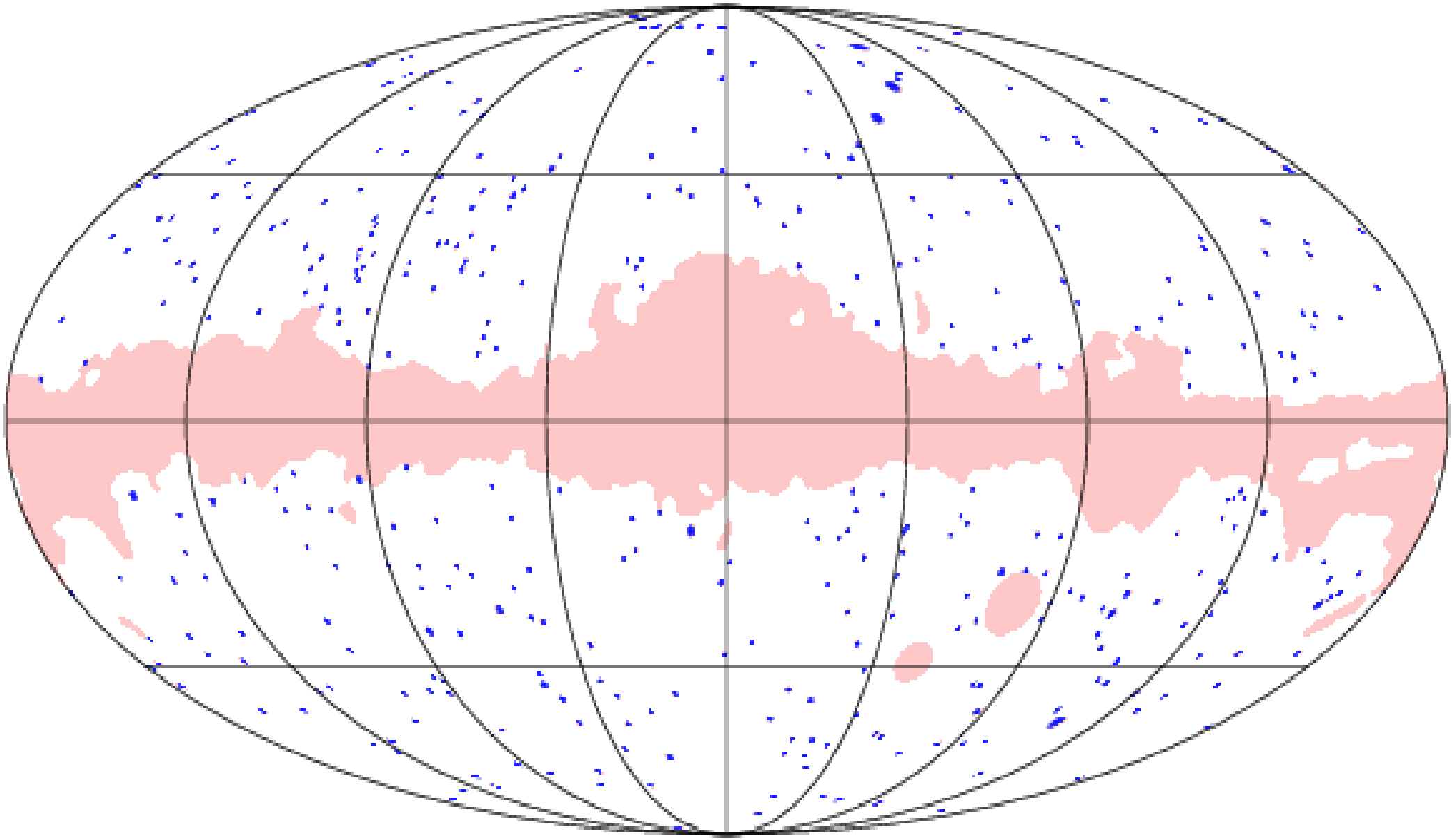
Final map of CMB anisotropy
internal linear combination map



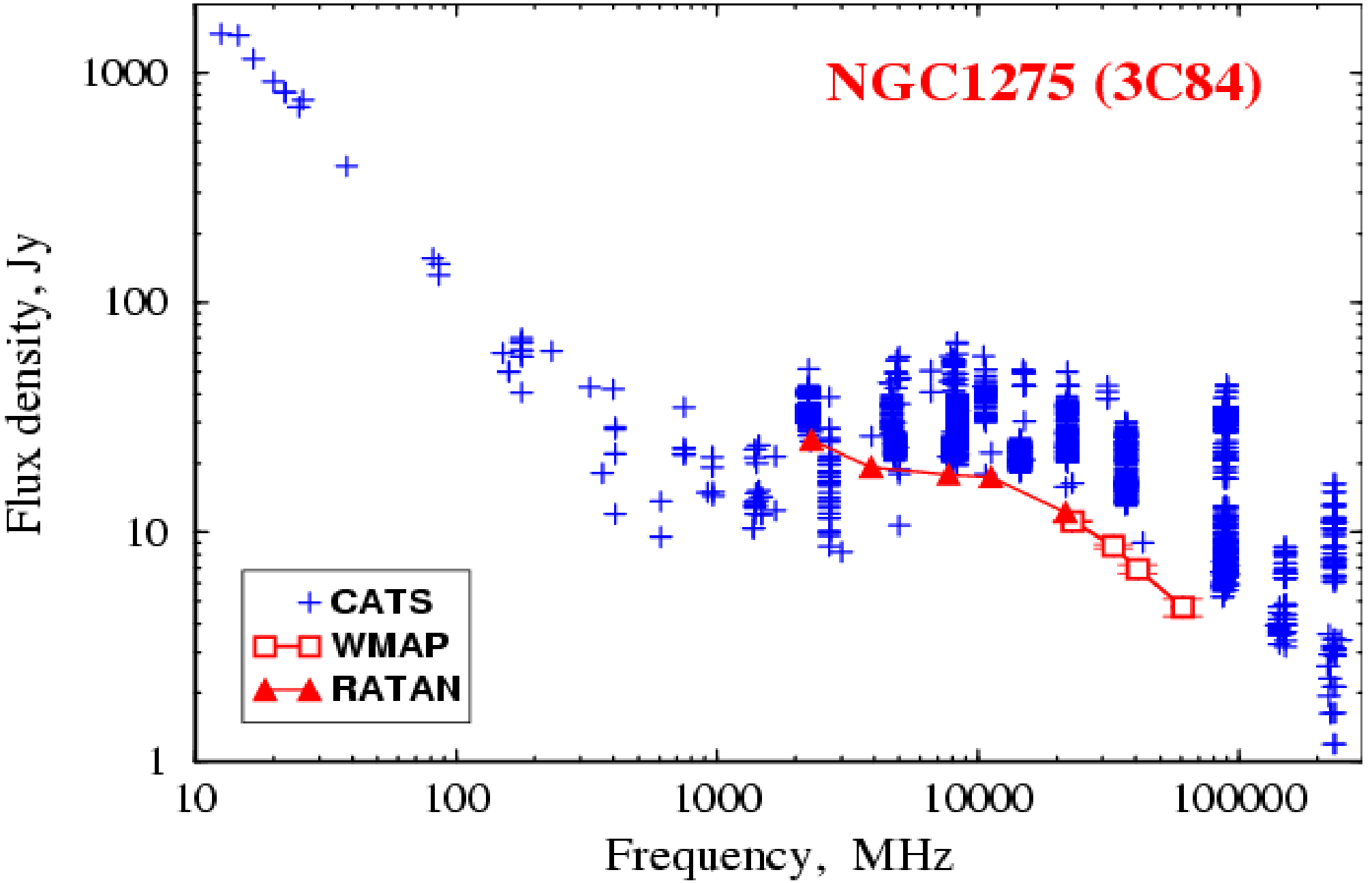
WMAP1 map with the sources



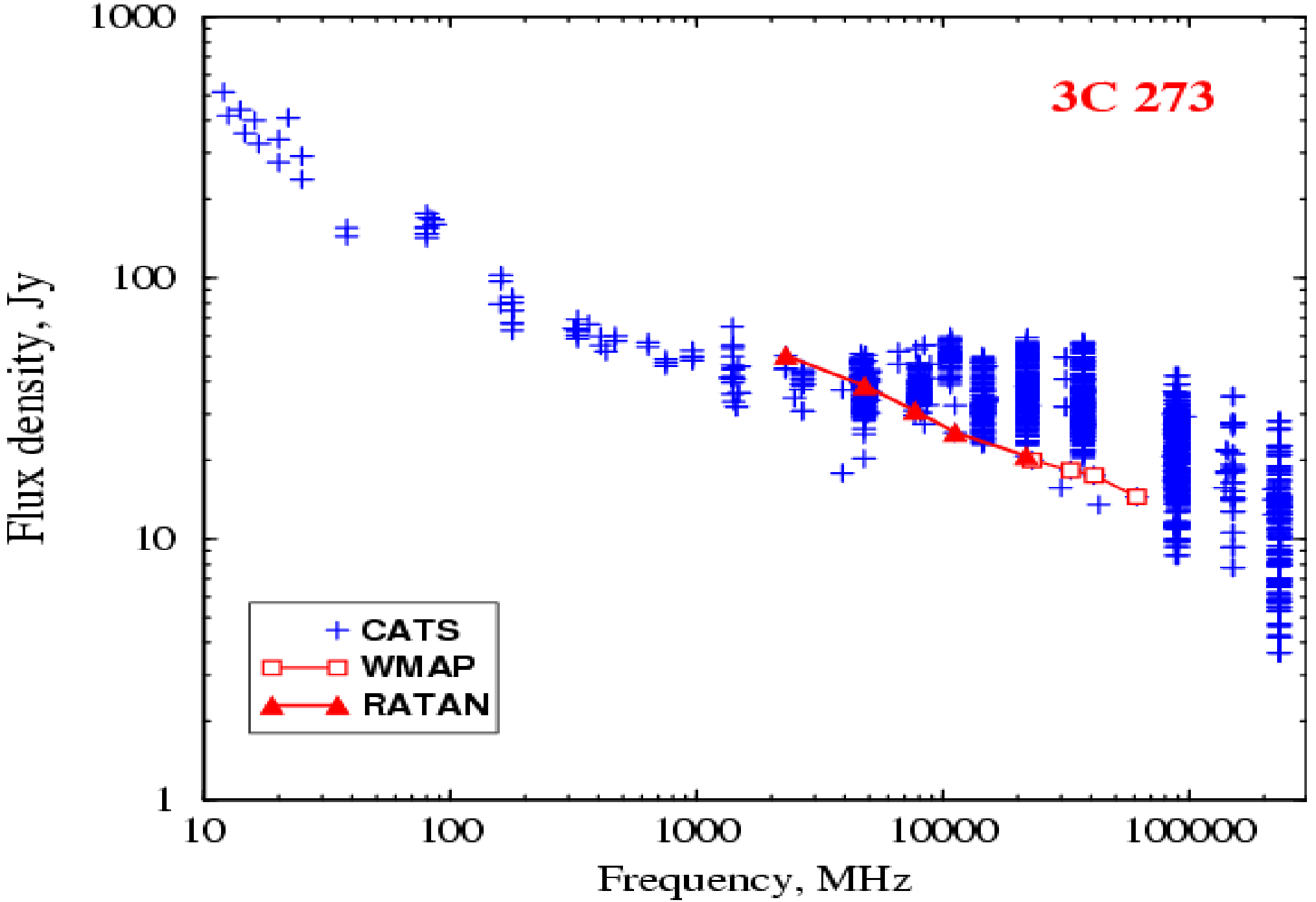
390 sources after five years



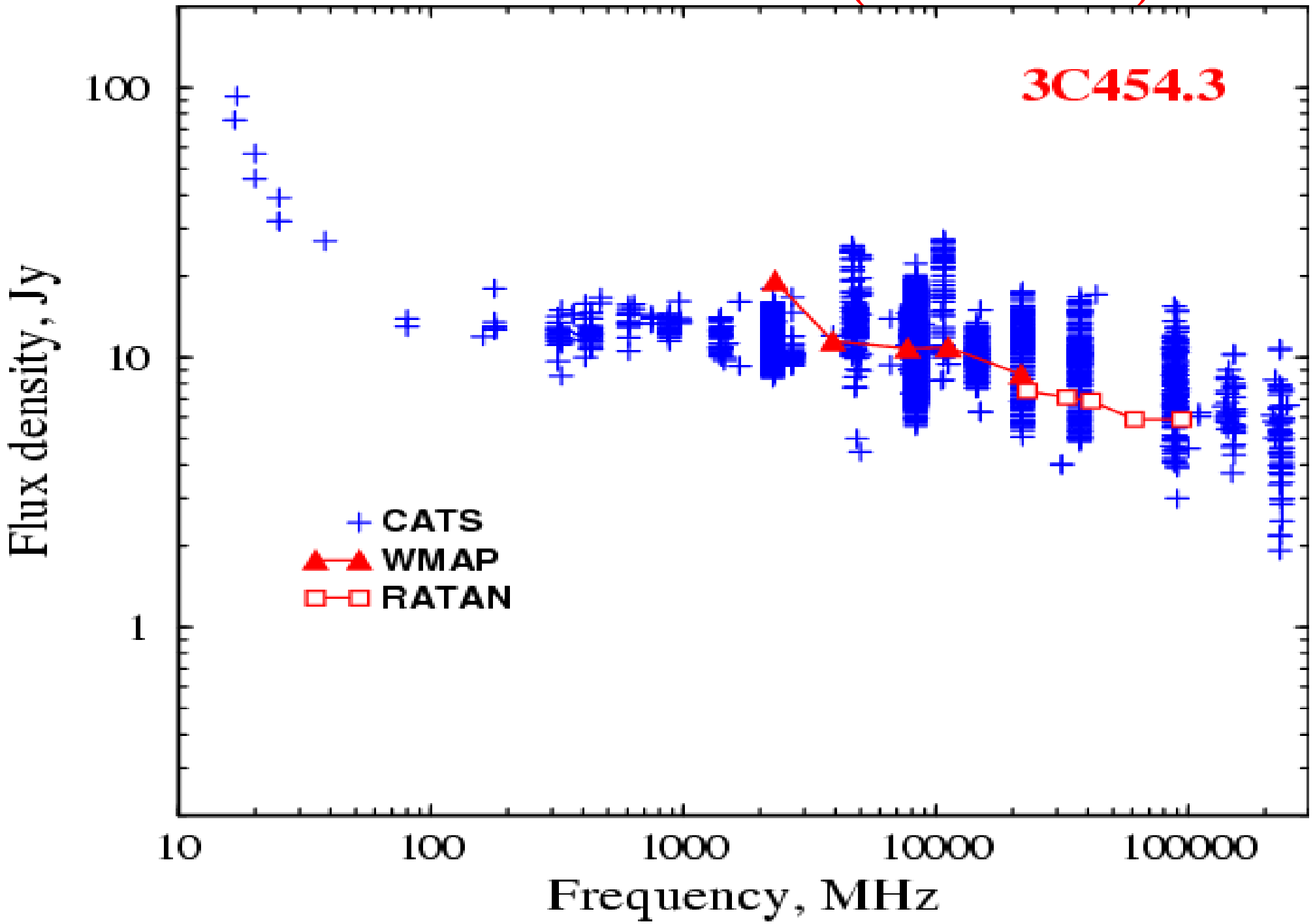
WMAPJ0319+4130 (3C84)



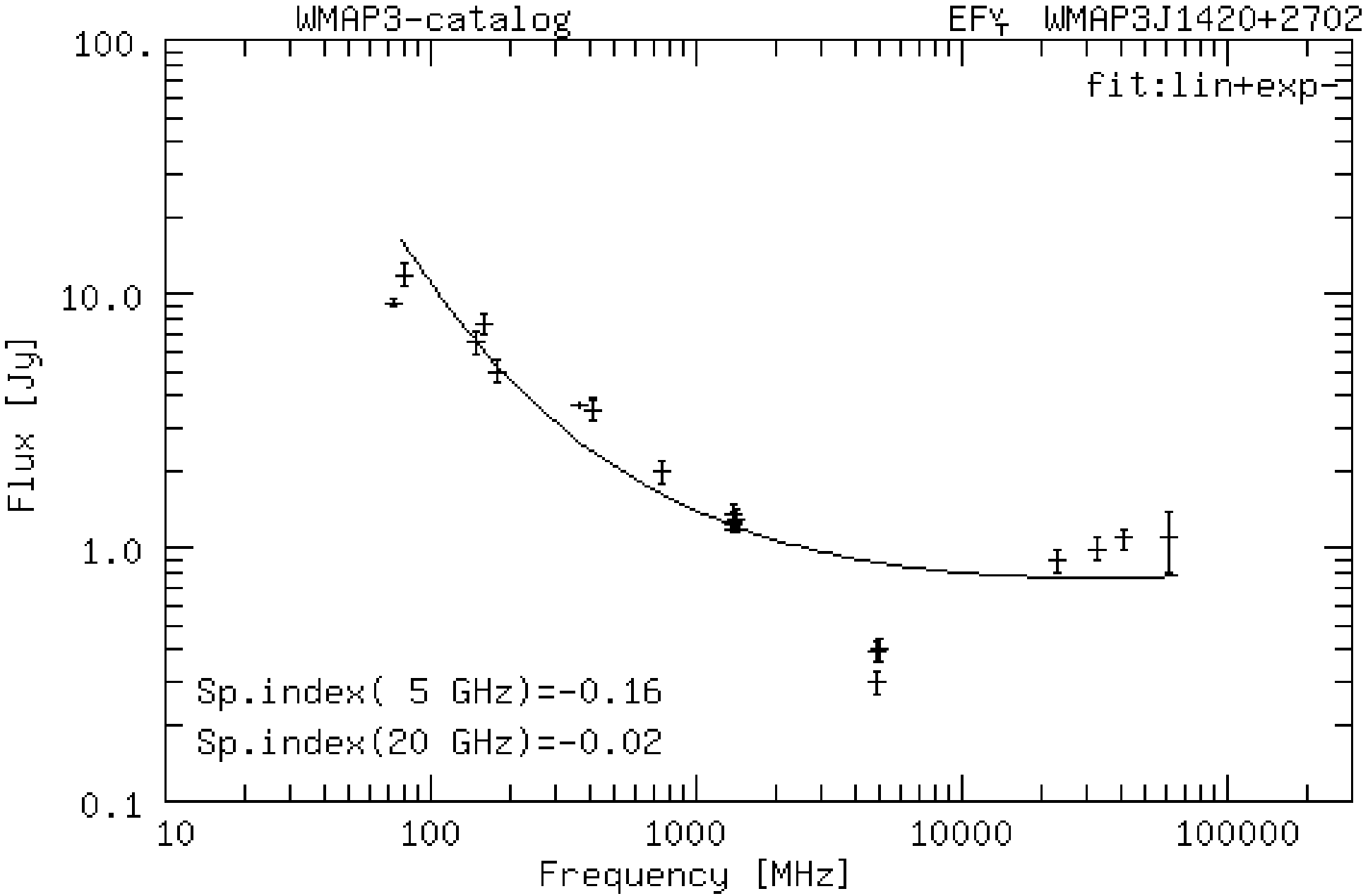
WMAPJ1229+0202 (3C273)



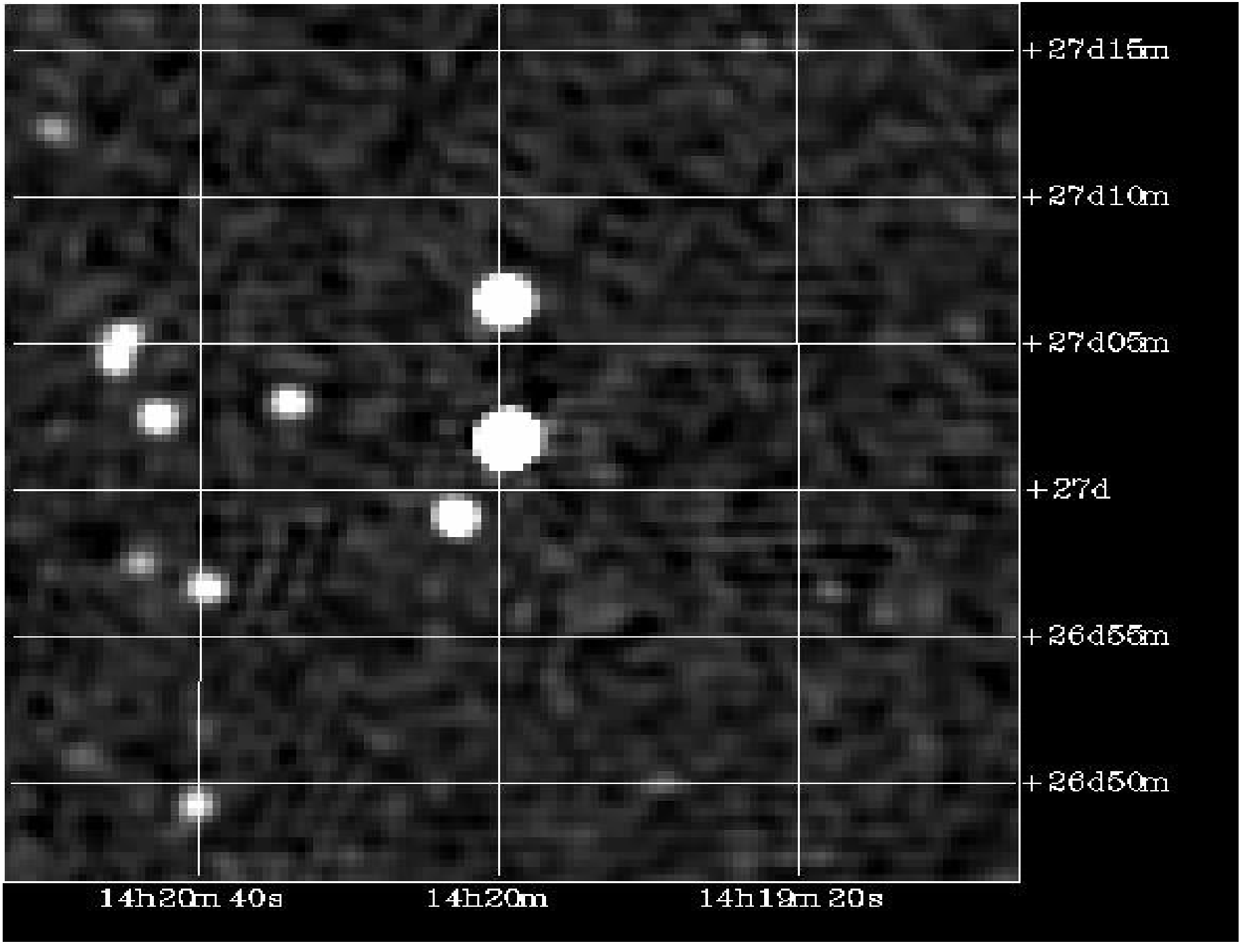
WMAPJ2253+1608 (3C454.3)



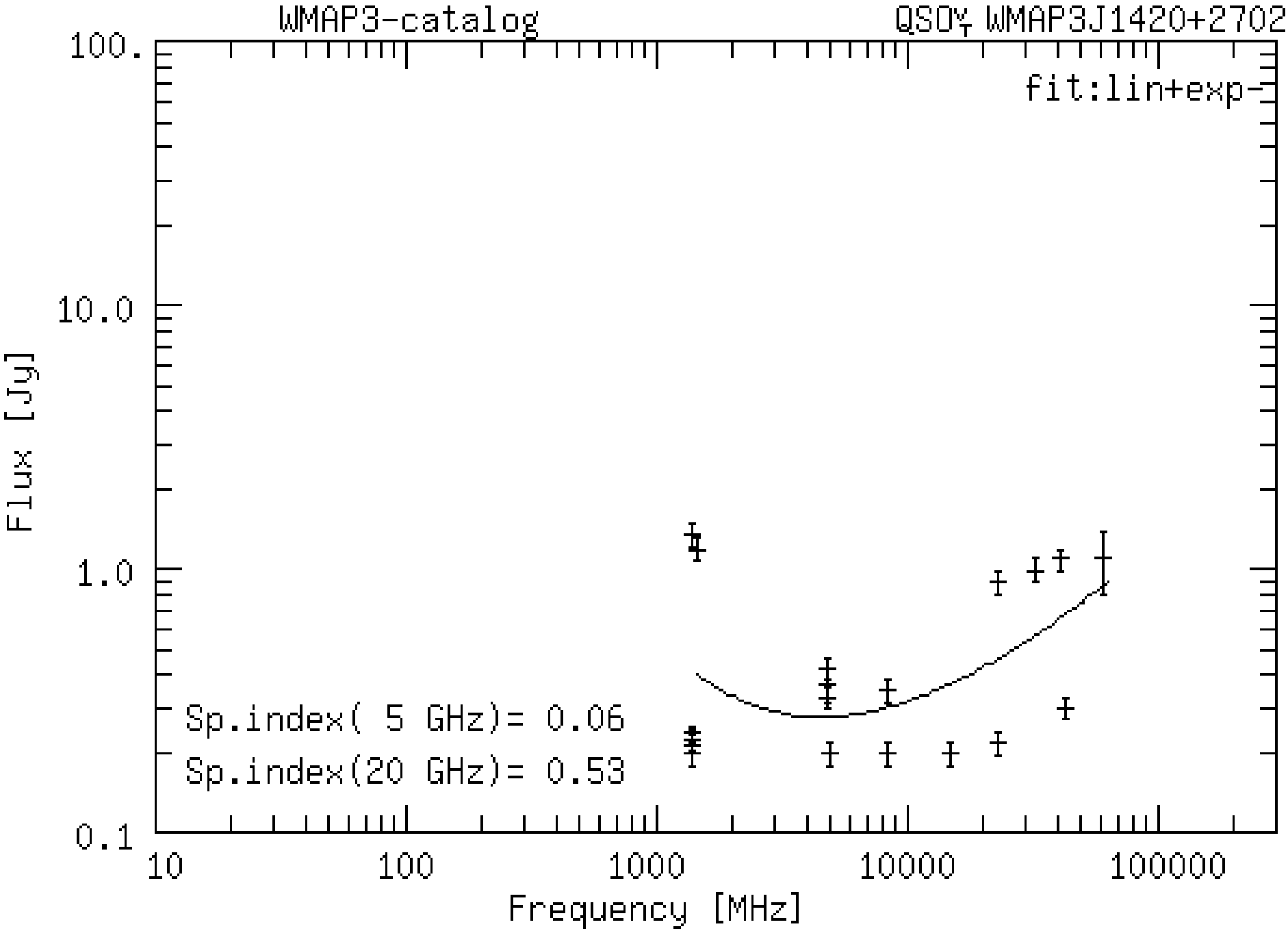
A “hard” case


WMAP3-catalog
EFν WMAP3J1420+2702
fit:lin+exp
100.
10.0
1.0
0.1
Flux [Jy]
Sp.index(5 GHz)=-0.16
Sp.index(20 GHz)=-0.02
10
100
1000
10000
100000
Frequency [MHz]

What source do we select?



Probably ?


WMAP3-catalog
QSO WMAP3J1420+2702
fit:lin+exp
100.
10.0
1.0
0.1
Flux [Jy]
Sp.index(5 GHz)= 0.06
Sp.index(20 GHz)= 0.53
10
100
1000
10000
100000
Frequency [MHz]

WMAP sources spectra

~60% sources have flat or inverted spectra,

~15% - spectra with maxima at 5-20 GHz (GPS-sources),

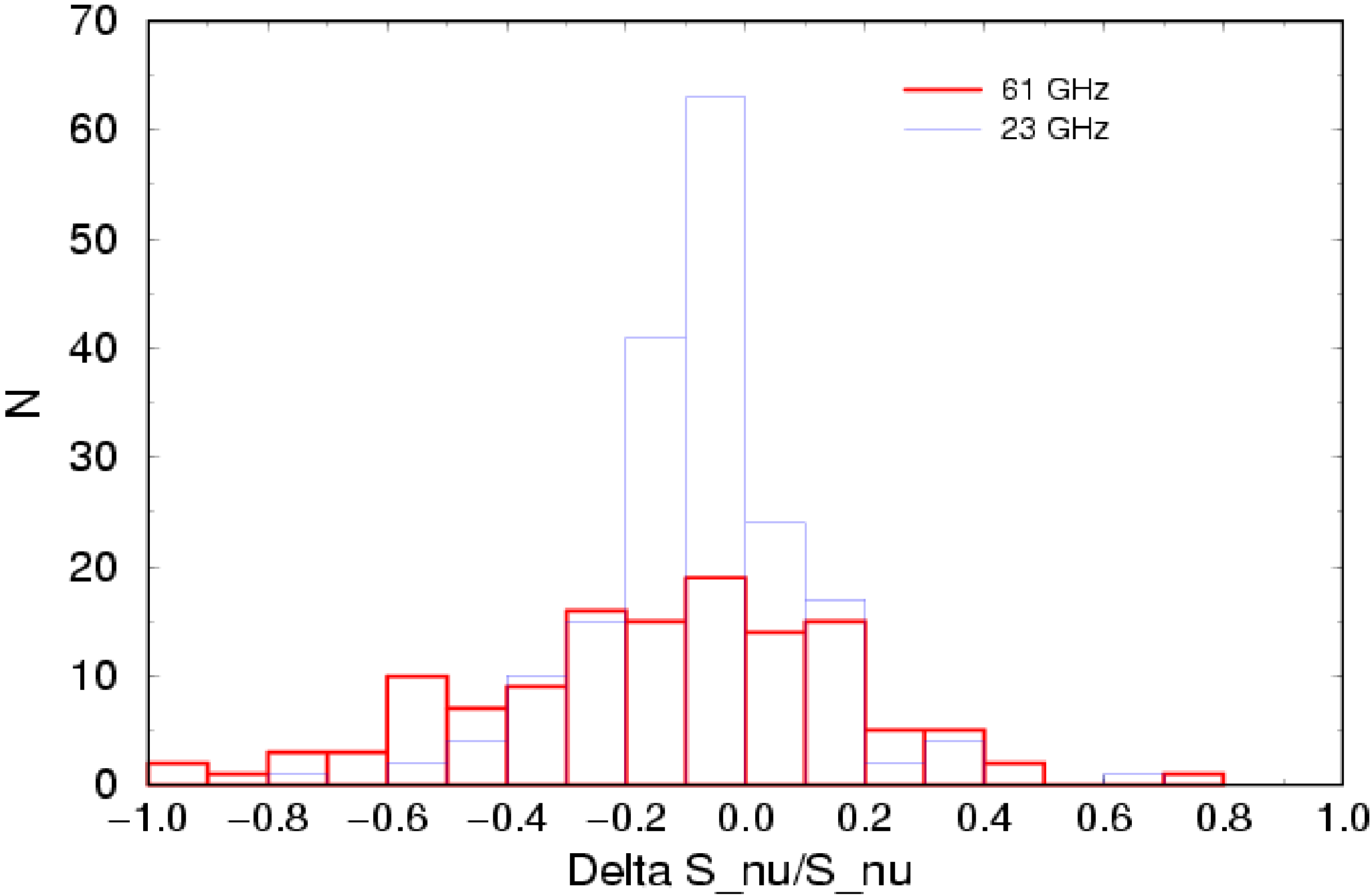
~15% - usual steep spectra,

~10% - combined spectra (as of 3C84)

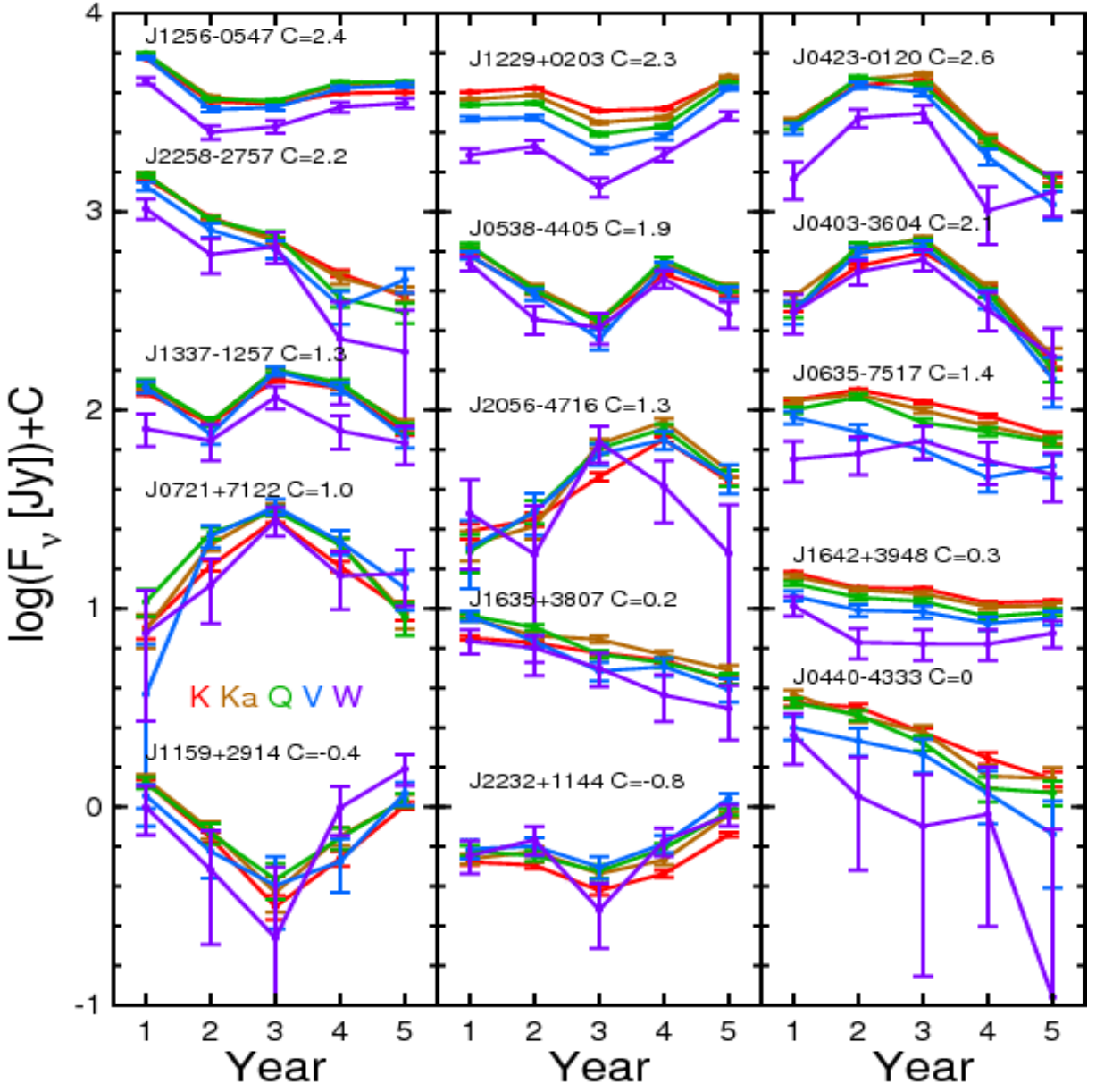
Statistics of identifications (IDs) after five years

- 220 - QSO [+79] {35} (10 incorrect IDs in WMAP catalog!)
- 30 - galaxies [+7] {10}
- 32 - ANGs [+13] {6}
- 30 - BL Lac objects [+11] {3}
- 1 – planetary nebula IC418
- In summa: 357 from 390[+4] have optical IDs
- 313 – XI catalog AGN+QSO+BL Veron's 2003
- 223+? – X-ray sources from ROSAT catalog
- 235 - sample of the sources > 1 Jy at 5 GHz (Stickel+, 1994)
- 50 - intra-day variable sources (IDV)

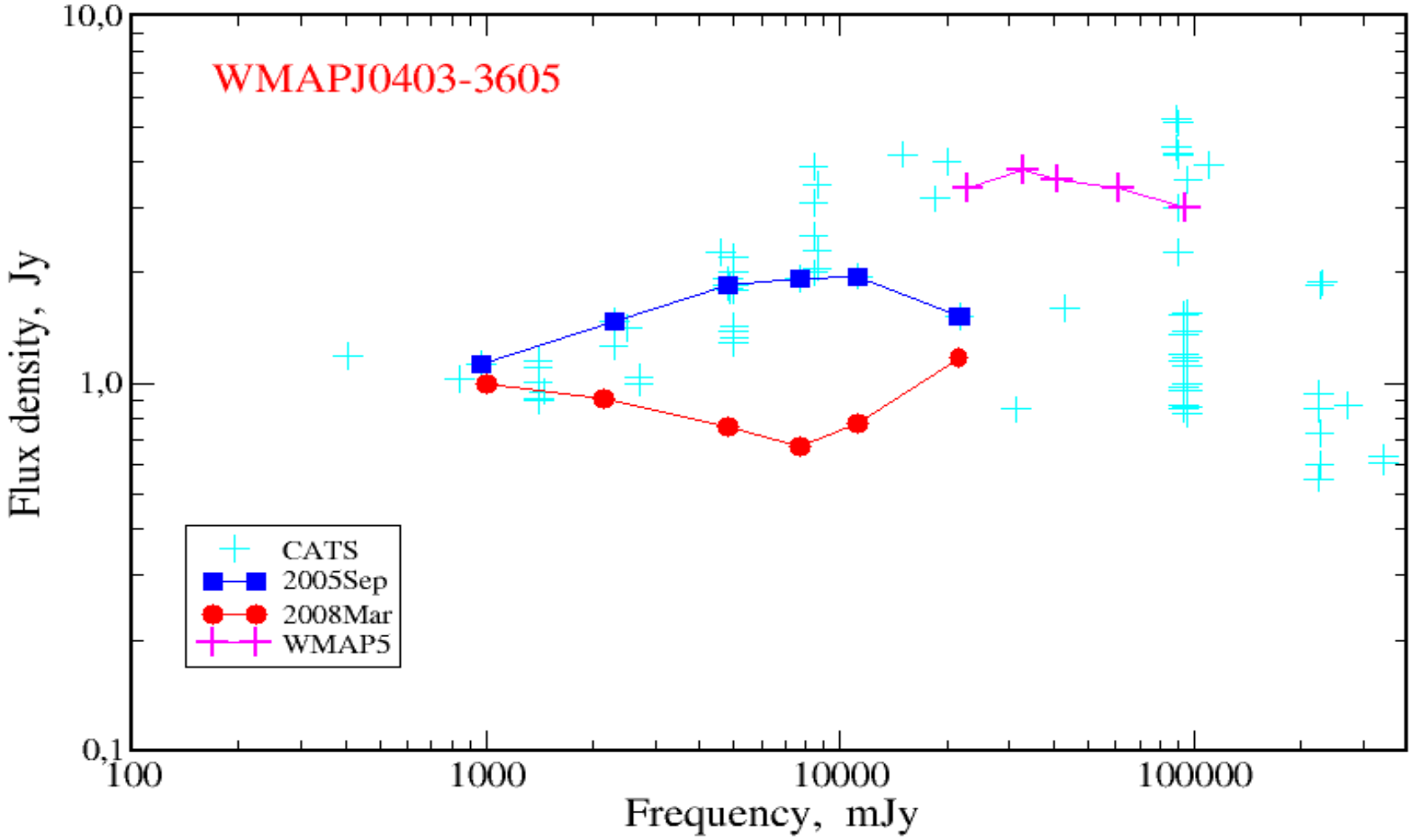
Variations at scale: 3year-1year



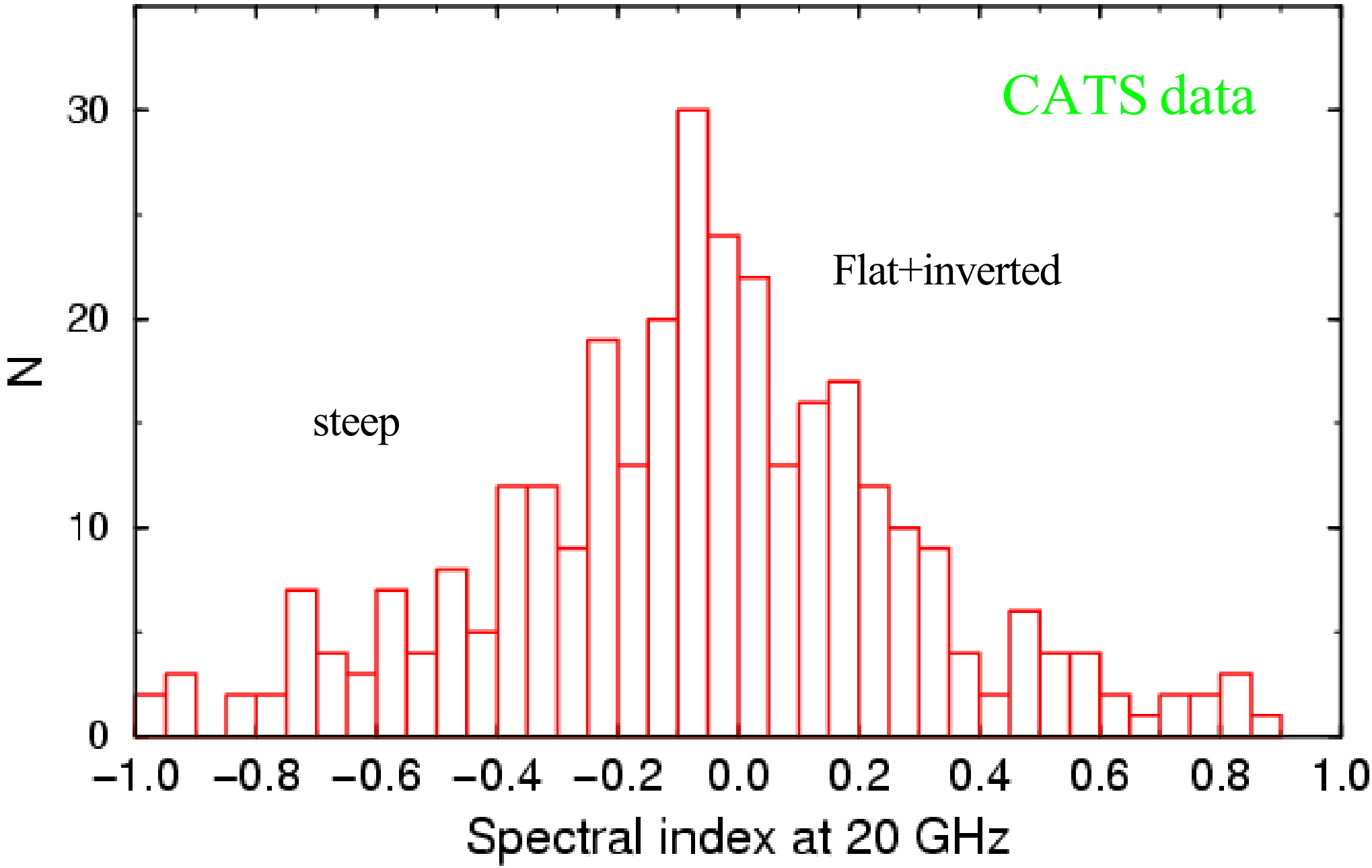
Variavility of WMAP-sources



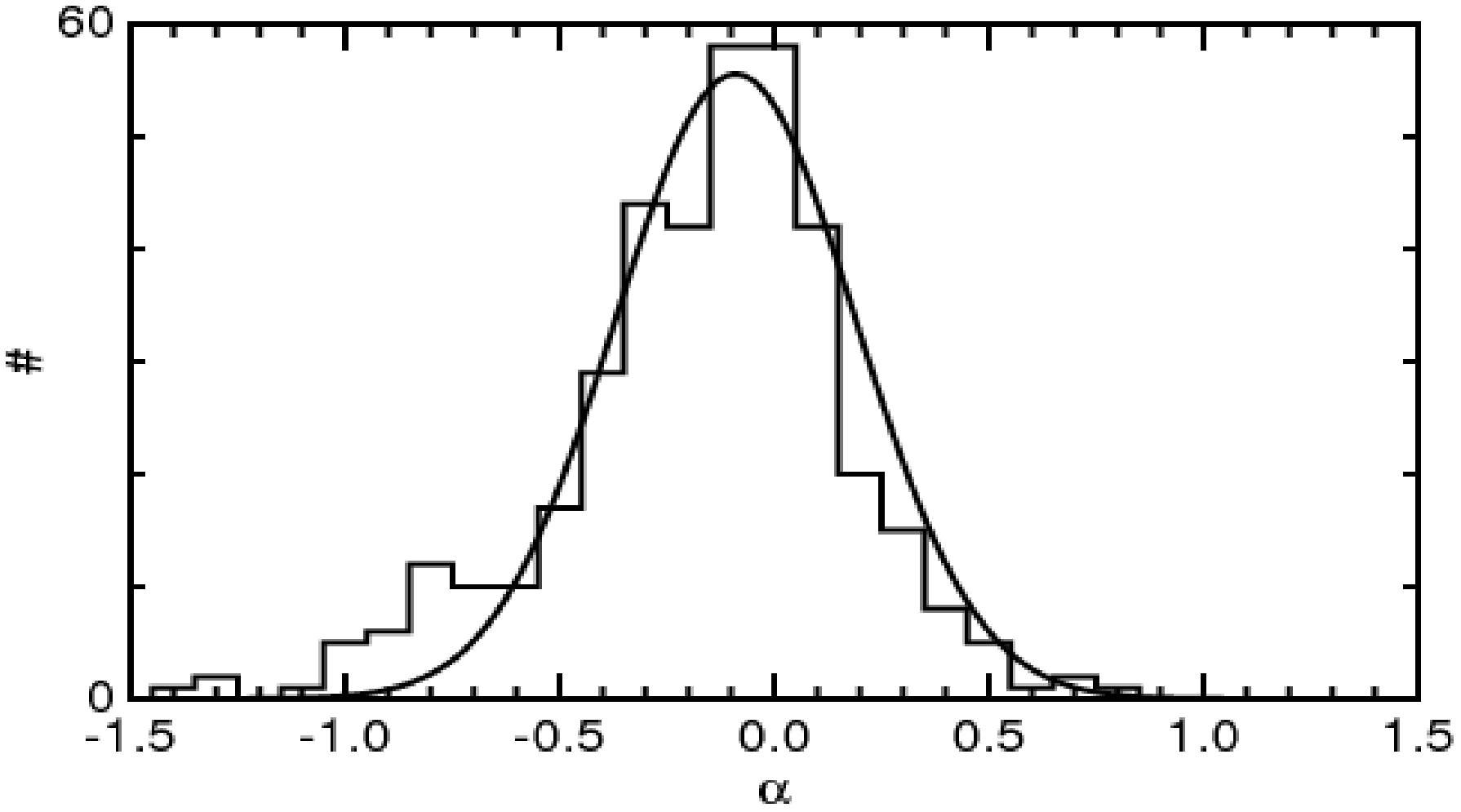
Variability of WMAPJ0403-3605



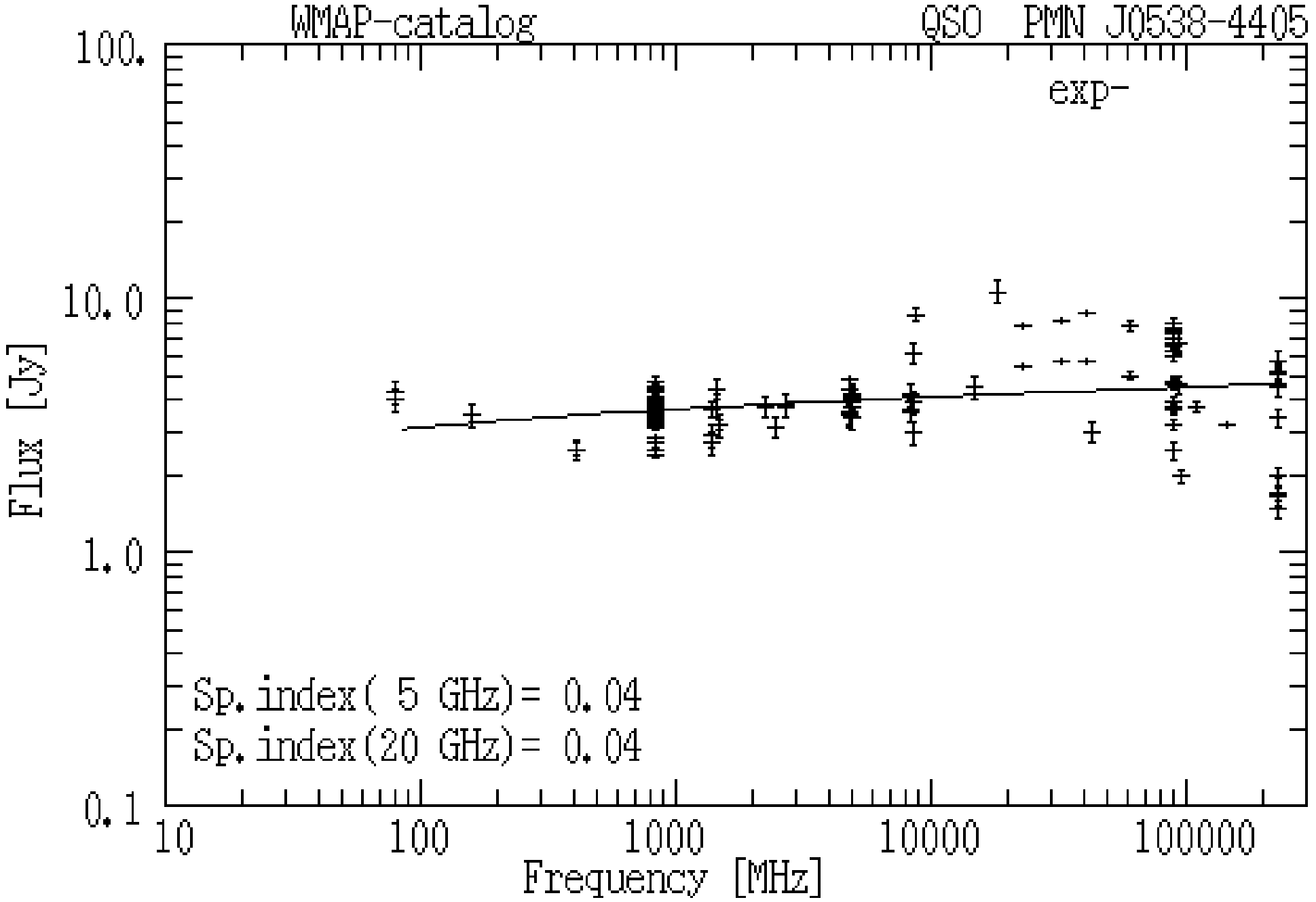
Spectral index at 20 GHz for 327 WMAP sources



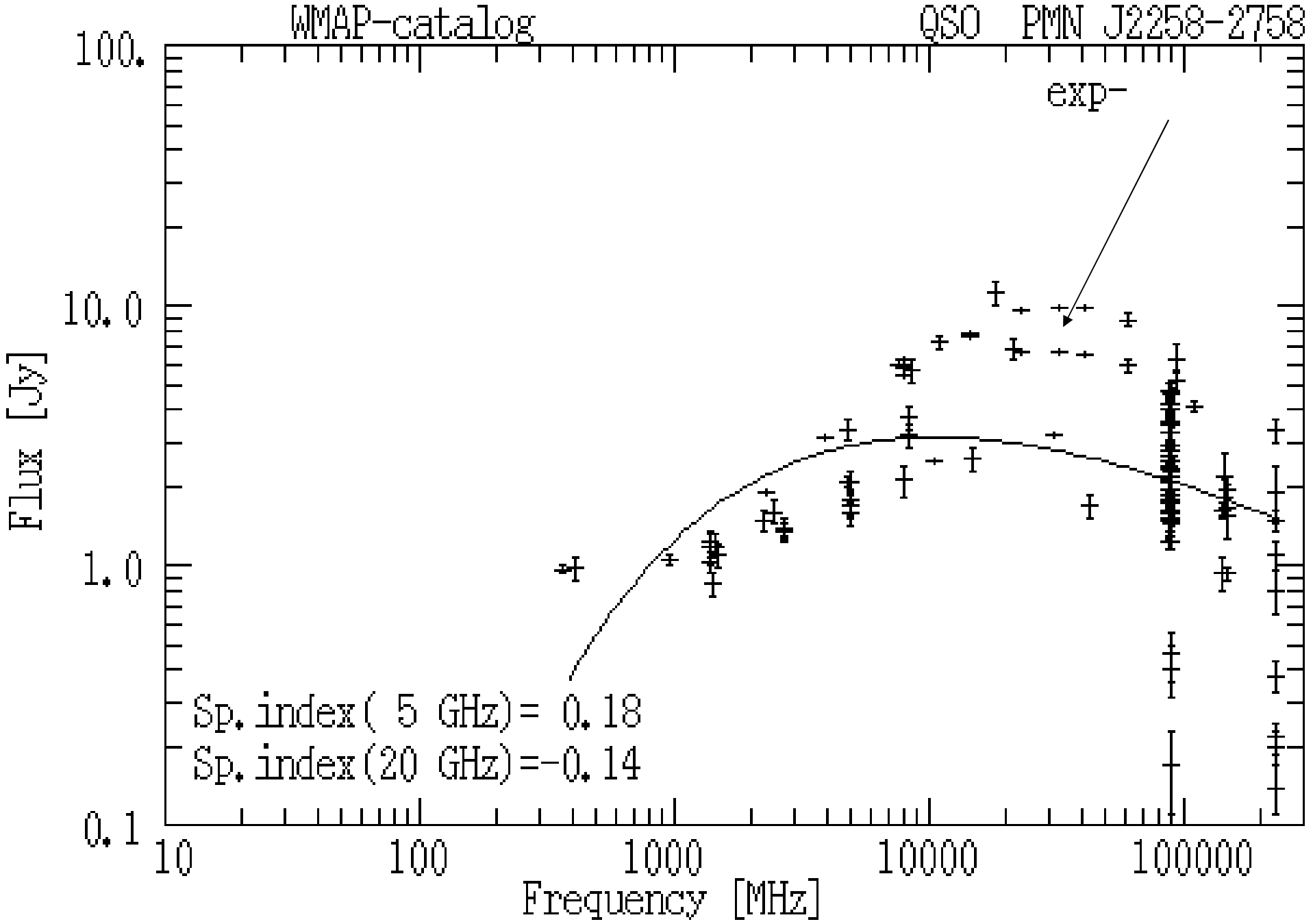
Spectral index at 23-94 GHz



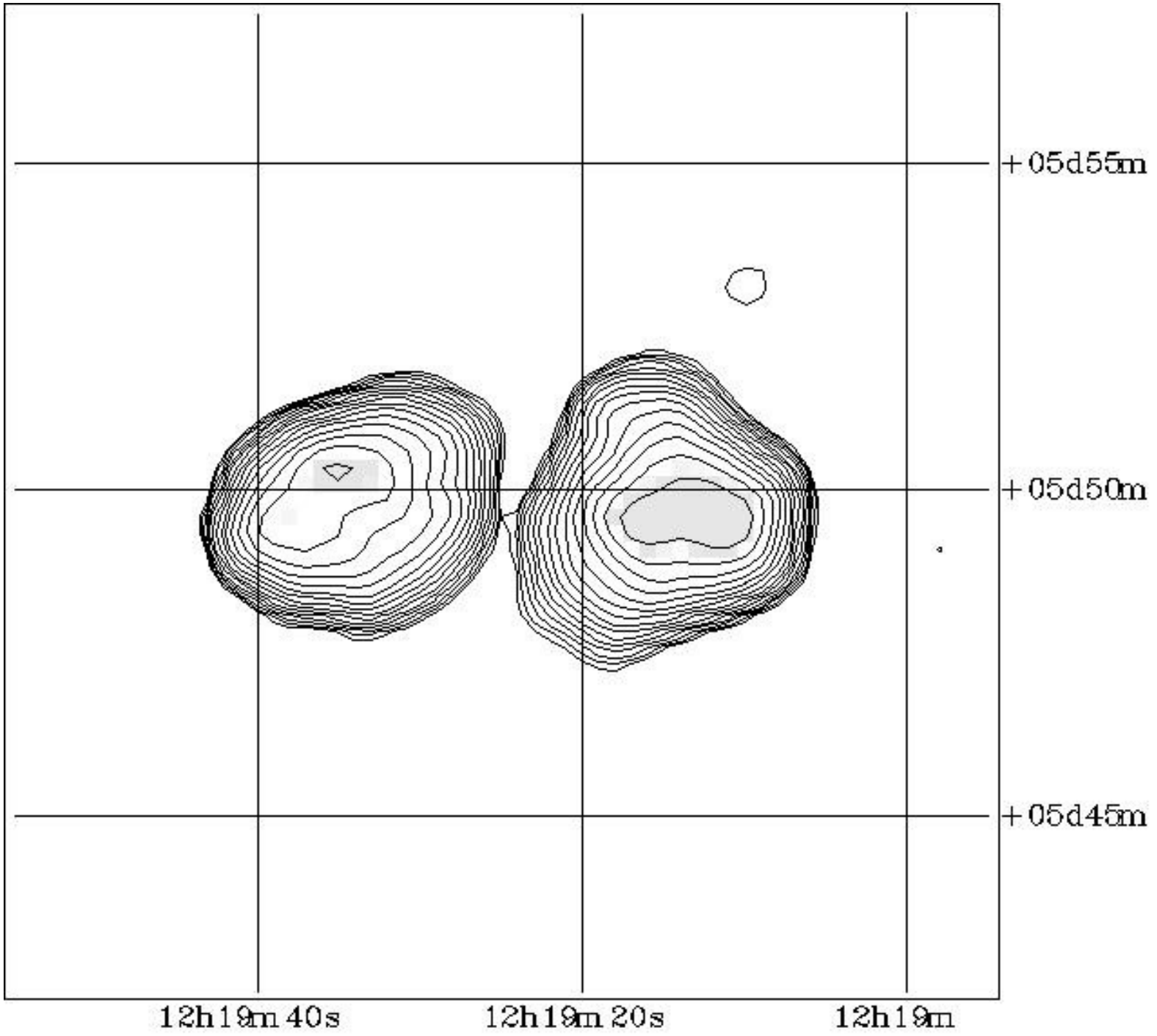
High variability at t~1 yr



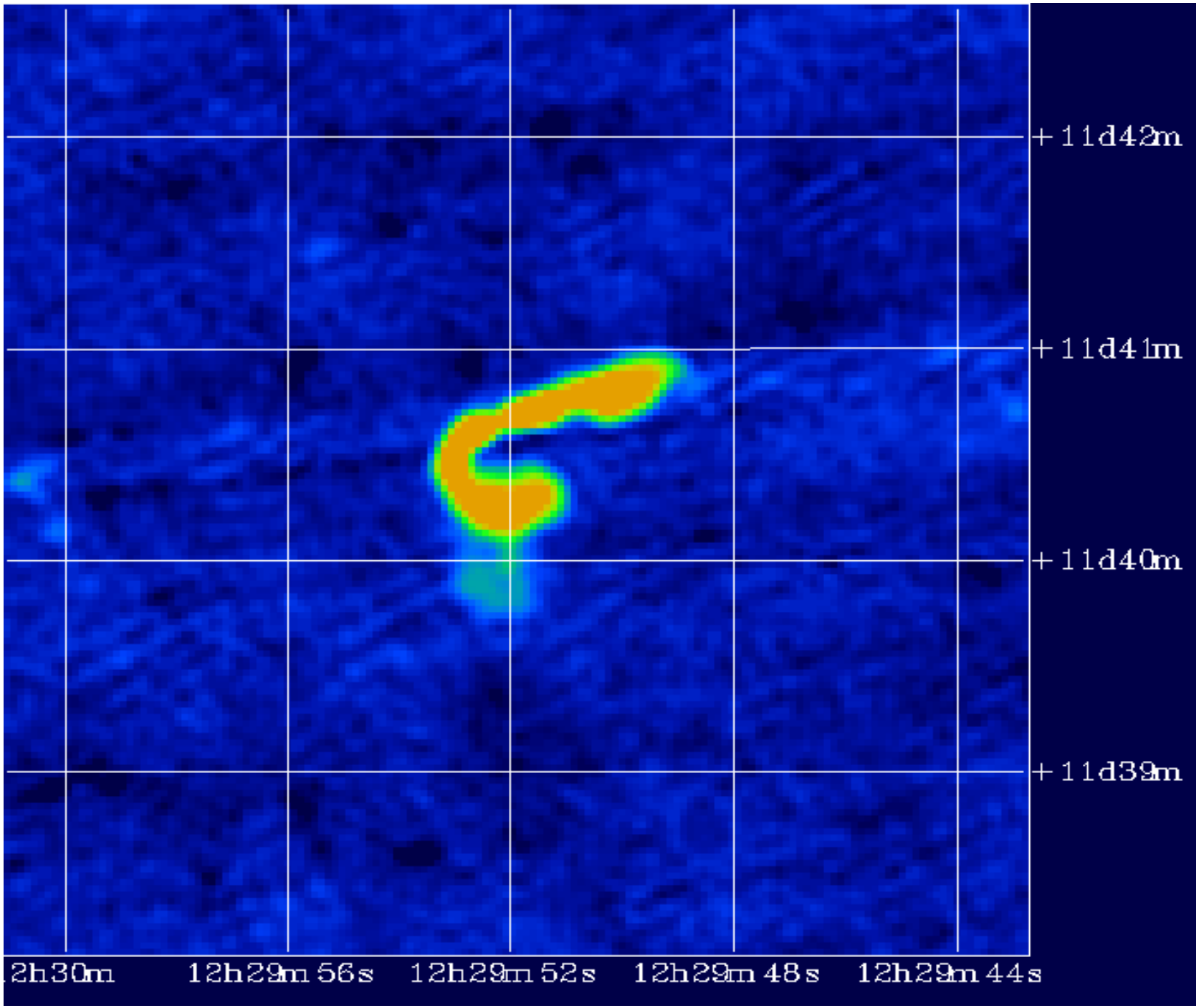
High variability at a scale ~ 1 year



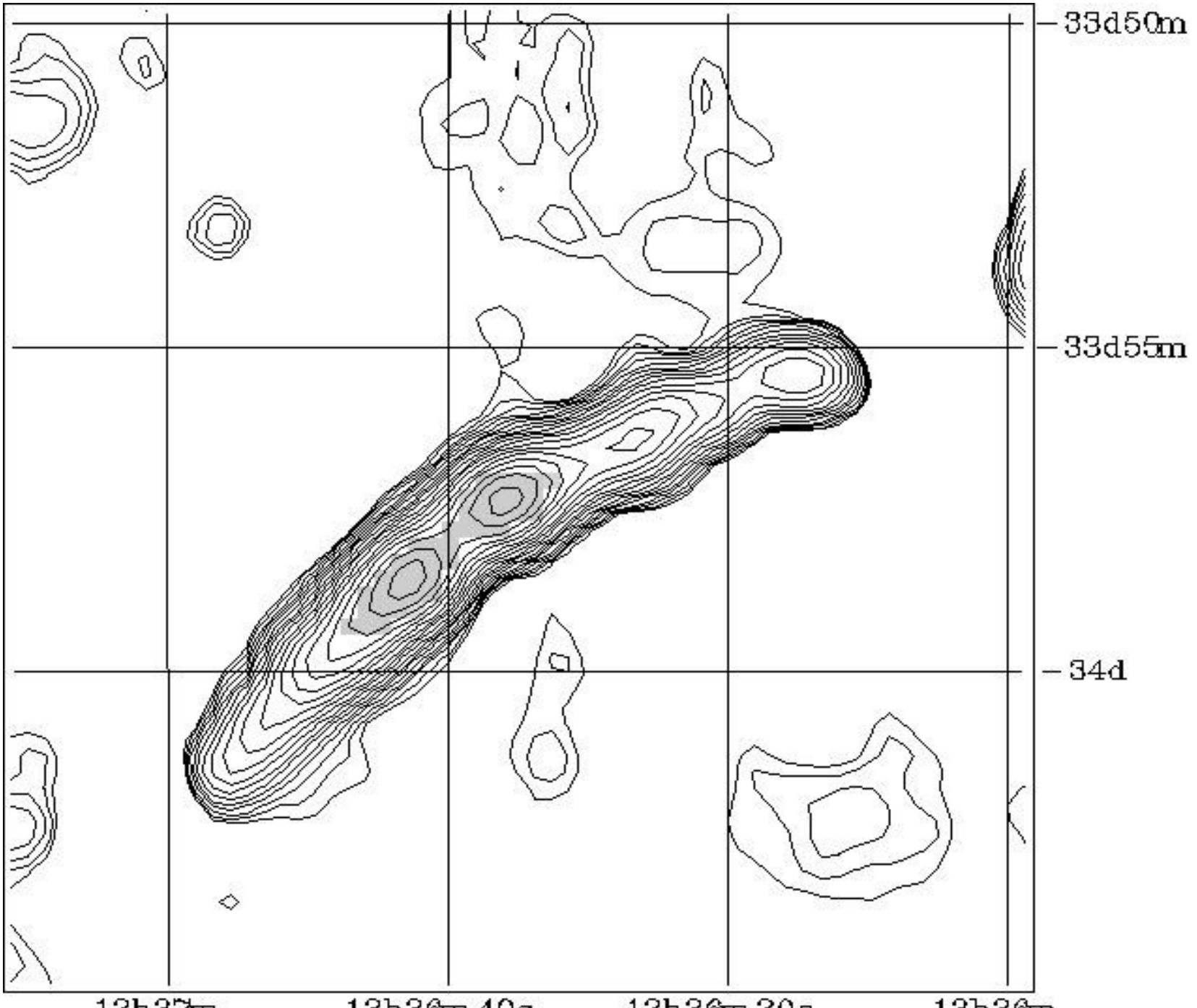
WMAP J1219+0550



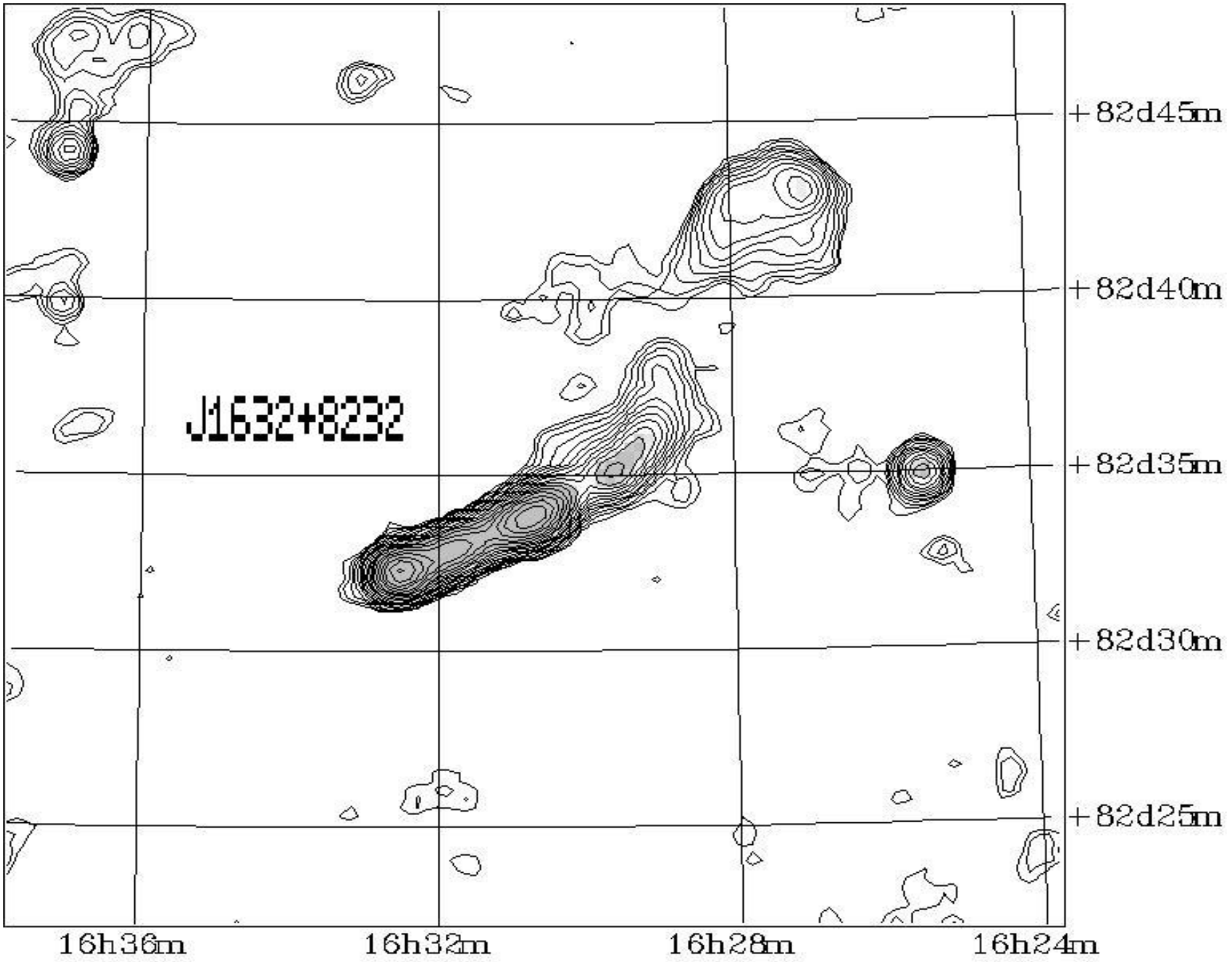
Bright radio galaxy F1226+1140



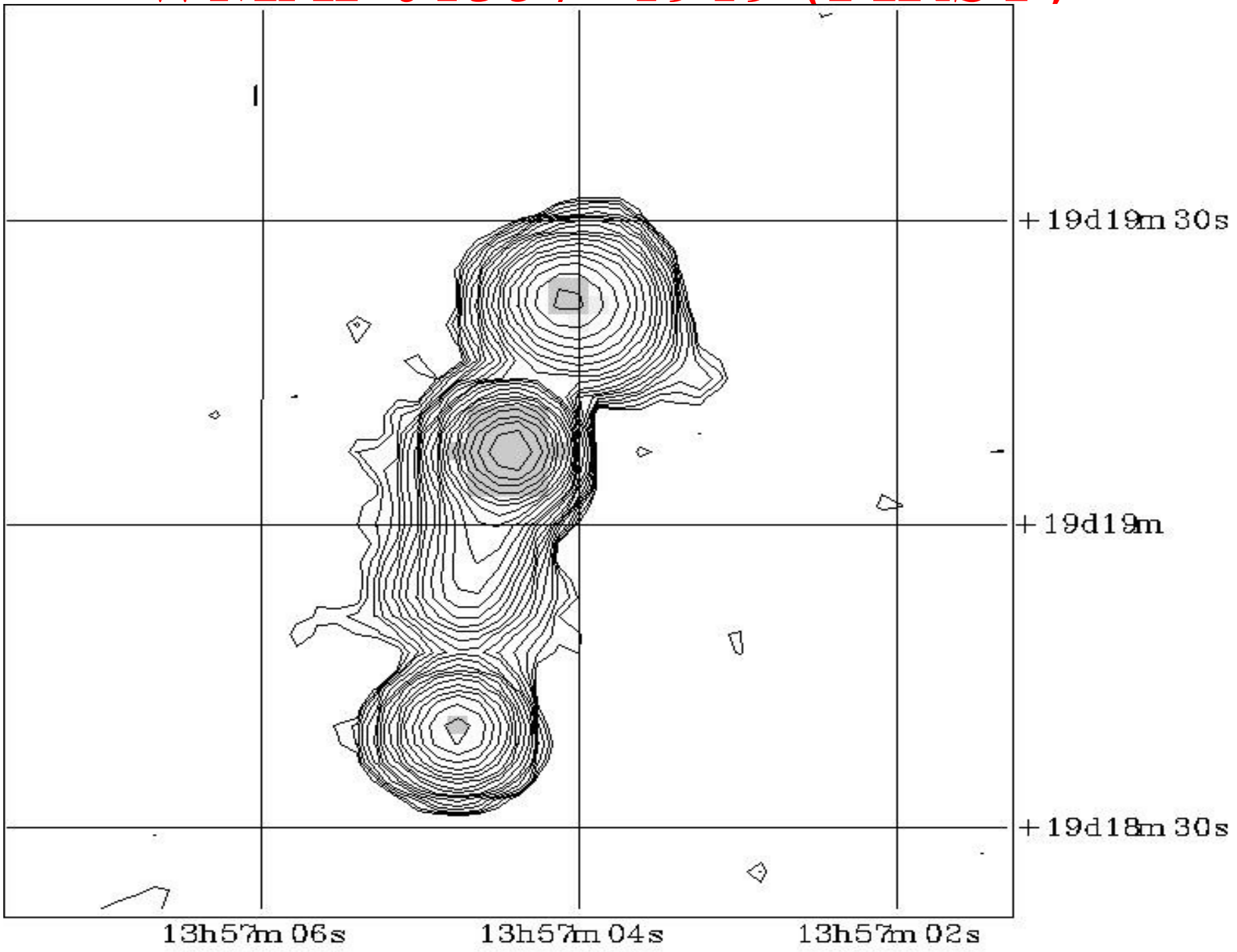
WMAP J1336-3356



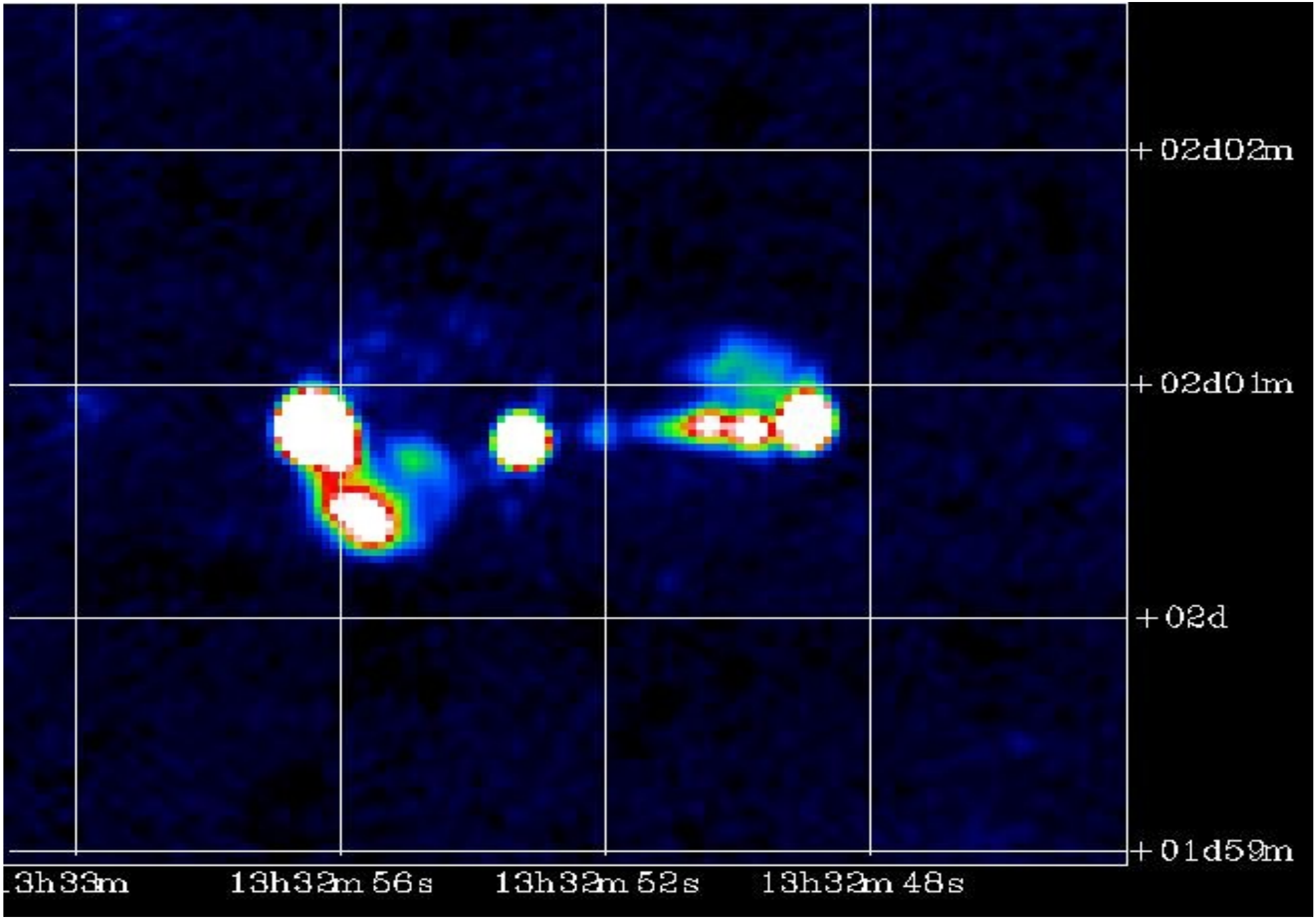
WMAP 1637+8232



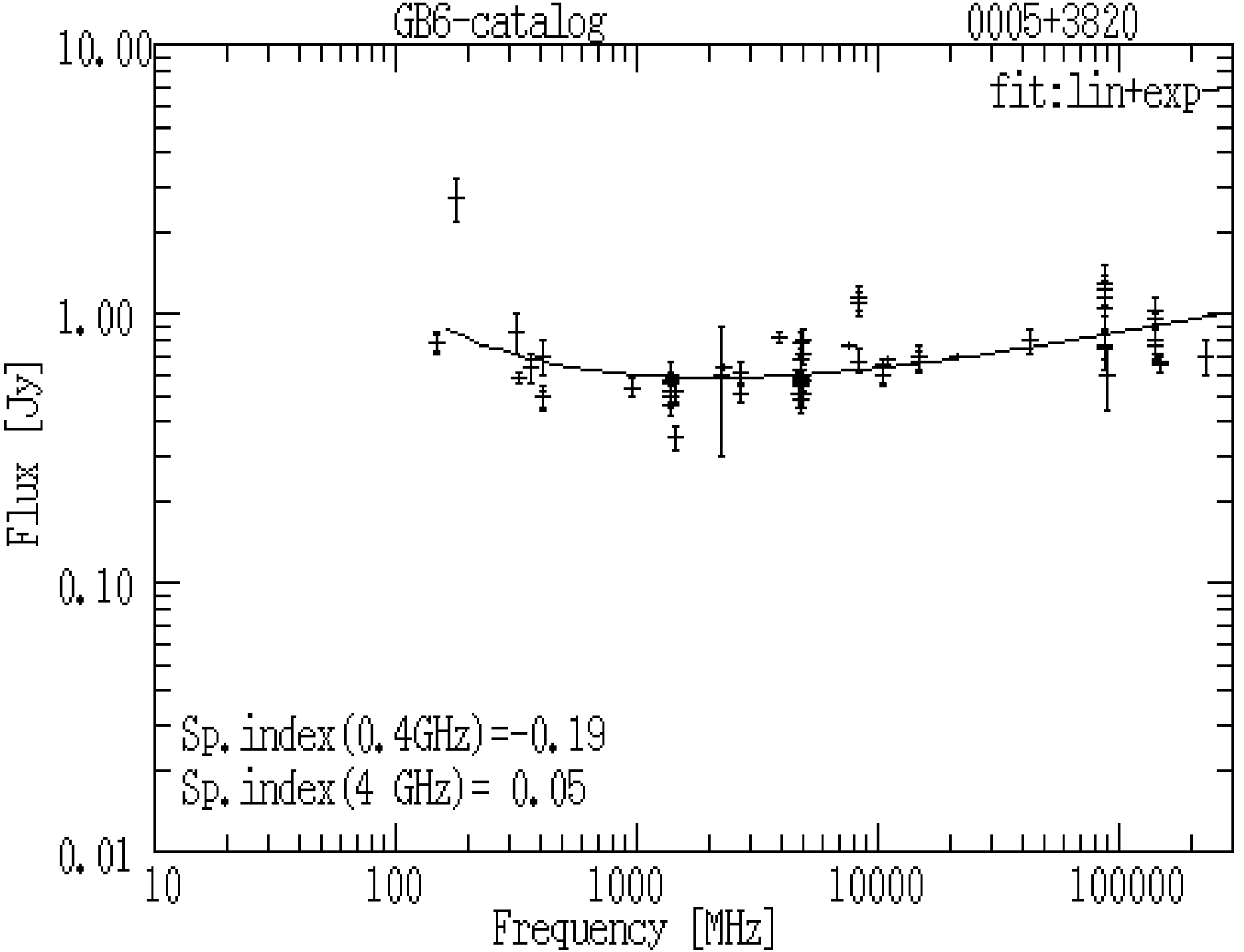
WMAP J1357+1919 (FIRST)



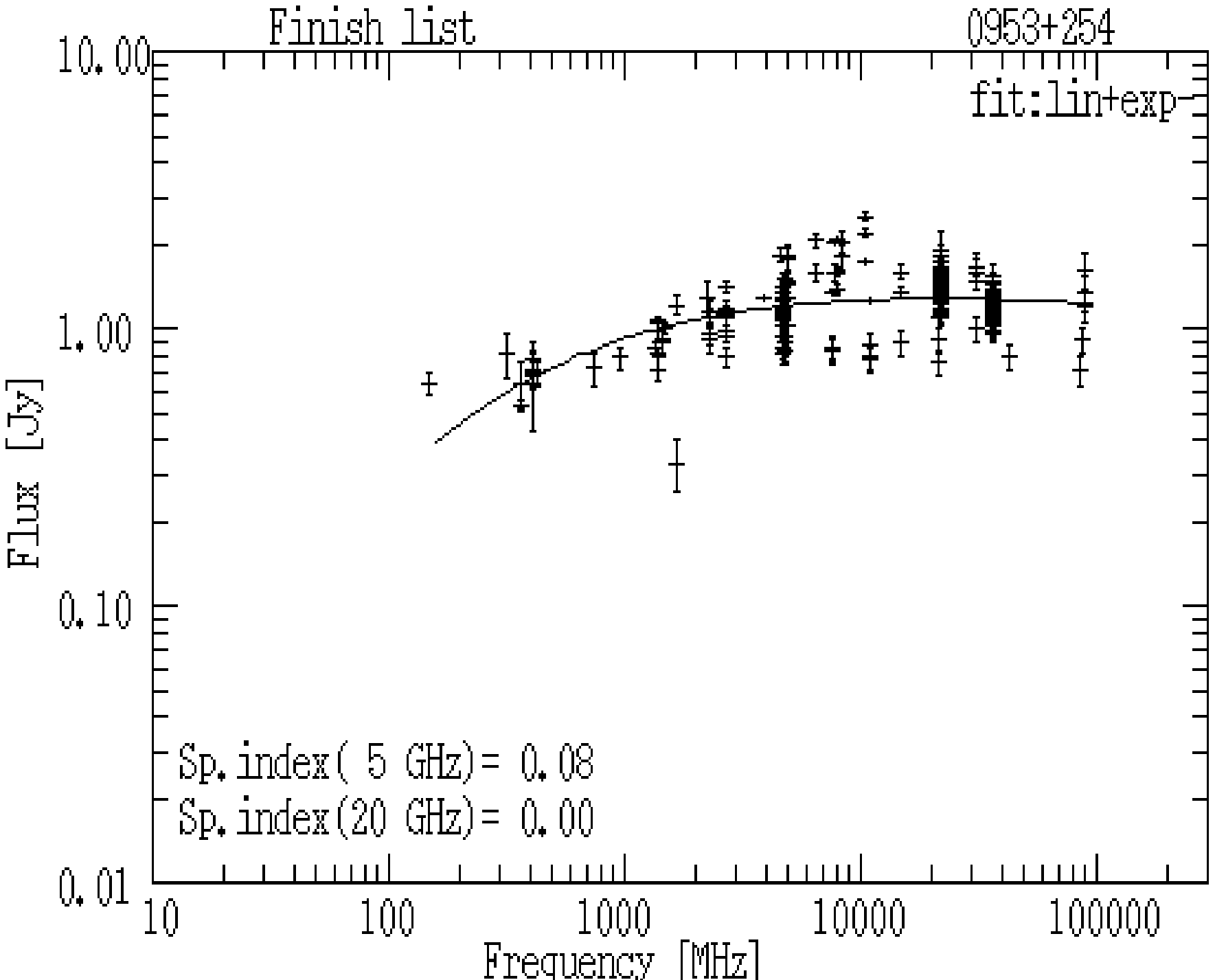
WMAPJ1332+0200 in NVSS



Not in WMAP? S4 0005+3820



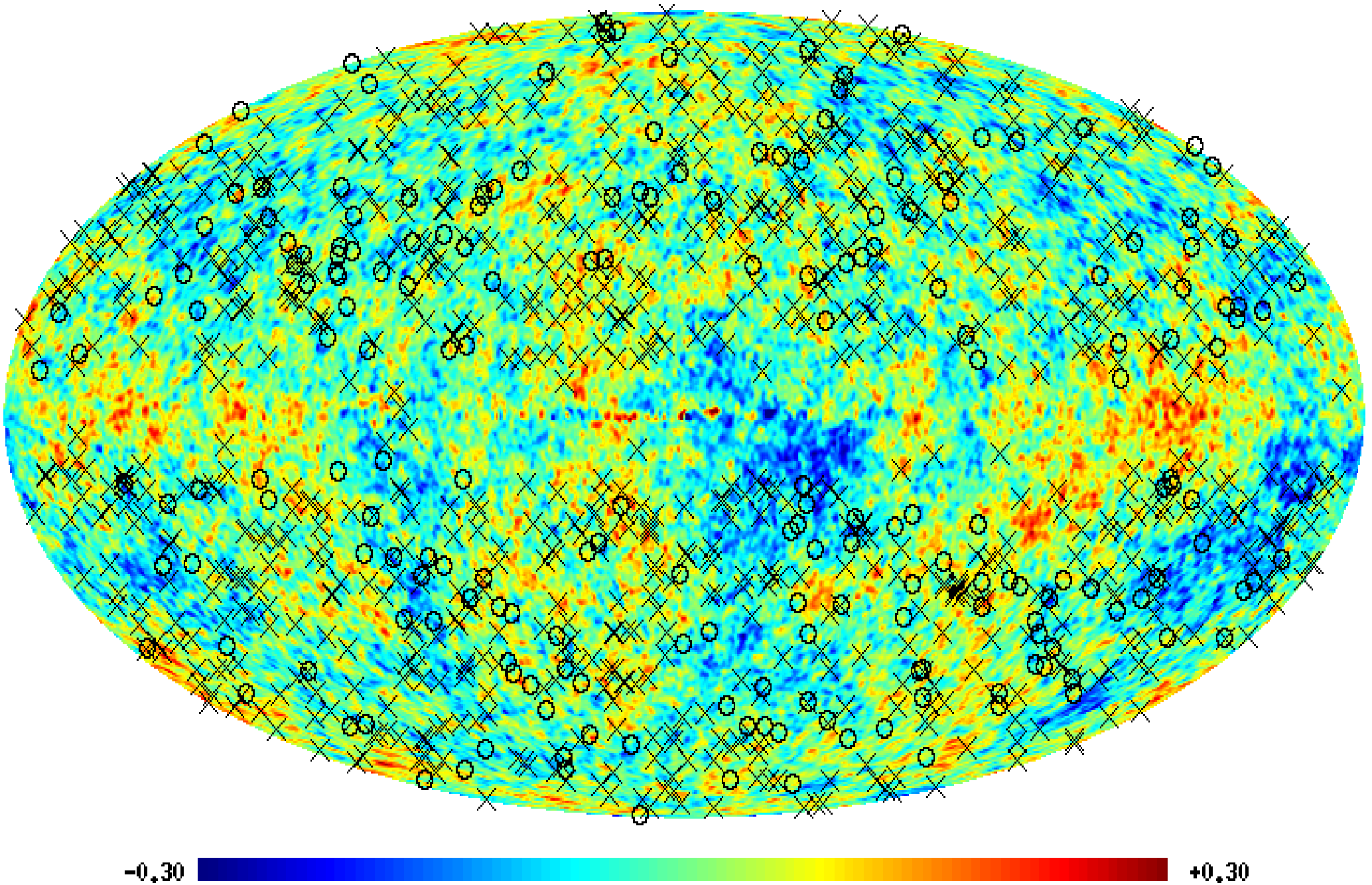
Not in WMAP? OK290



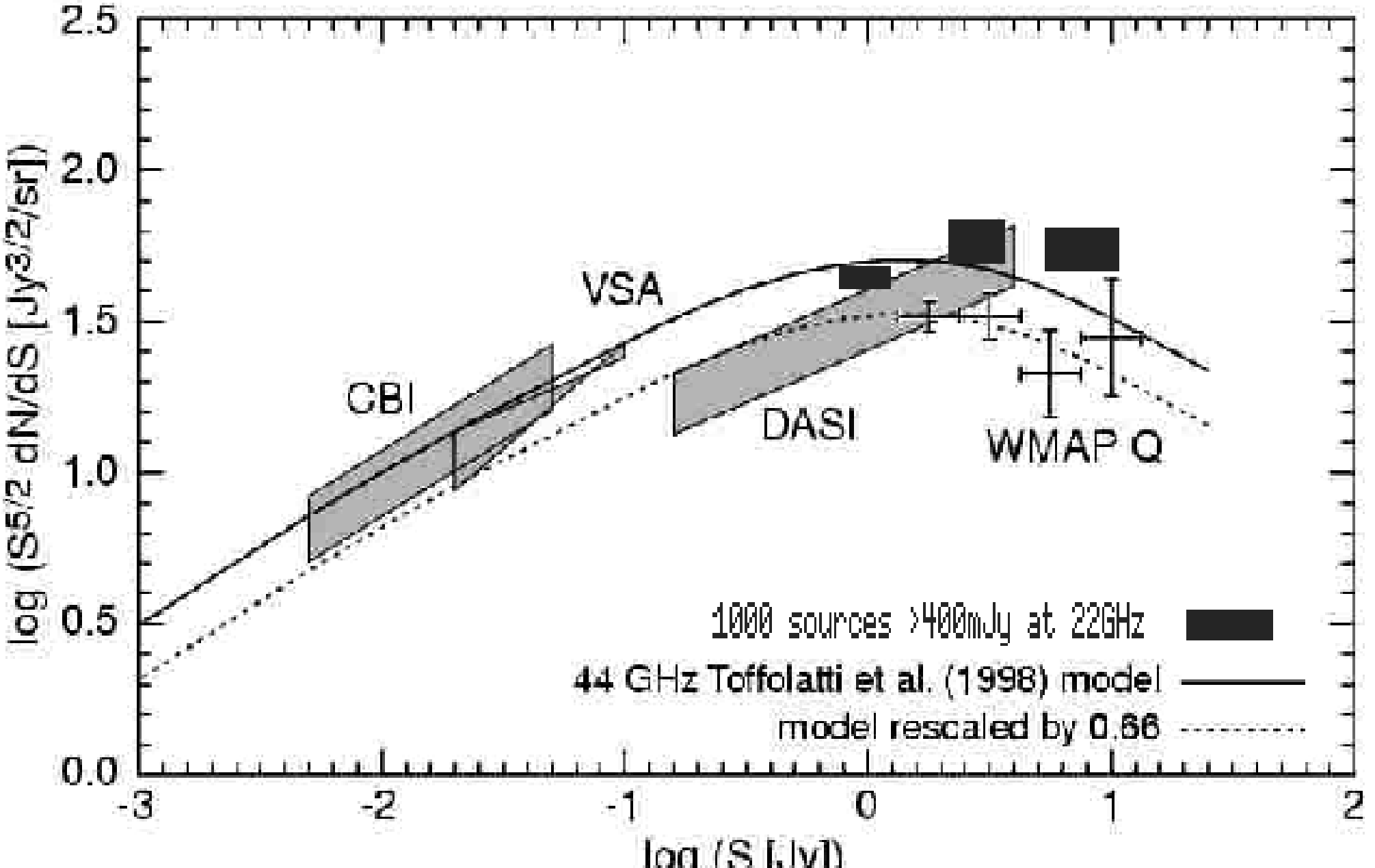
Numbers of bright sources in:

- NVSS(1.4 Ghz, 2mJy, <132"): >5 Jy 177 src (132extended =75%)
  N=~1800000 (for Dec>0) >0.4 Jy 5300 src (56%)
- (mean sp. index = -1) >1.4 Jy : 708 src (1500) (61%)
- GB6 (5 Ghz >25 mJy, 75000): >0.4 Jy : 1692 src
- PMN (5 Ghz >20-50mJy,50800): >0.4Jy: 2705 src
- Thus roughly 1000-2000 src have flat spectra at 5 GHz
- We found with CATS ~1300 src >400 mJy at 22 GHz

~1000 src >0.4 Jy at 22 GHz



Point source counts from WMAP compared with Toffolatti+1998 model



Two new data-reductions of WMAP maps

- WMAP , T-maps+ filter b_l/(b_l*C_cmb +C_noise) 5yr => 390 sources at 5-sigma level (+60 ILC/CMB)
- Nie et al. 2007 (CC methods+ ILC maps + imaps +Tagmark-maps) => 26 NEW sources at 5sigma
- Lopez-Caniego et al. (2007) non-blind 2491 src >0.5Jy at 5 Ghz – imaps, local backgrond, MH2 filters 98 NEW src at 5 sigma (11 from Nie+)
- S.A.T. : catalogs from CATS S>400 mJy at 22 Ghz list : ~1300 src included 60 src from L-C+ 13 from Nie+

Statistics of 98 src from Lopez+

- 4 are in WMAP3 catalog
- 21 - AGN+Gal
- 45 - QSO
- 4 - BL
- 2 – HII; 3 - PNe ; 3 SNRs (Kepler+ CL+LMC)
- 15 – rest are un-identified
- Ex: Cen A; OV-236; 3C111;3C353; 3C161, 1345+12
- ~45% -flat spectra; 15% GPS; 15 % steep 10% gal.src

WMAP catalog is not complete

- 390 soures >0.4 Jy at 23 GHz |b|>10d were detected with optimal filtration of the initial maps at the 5-sigma (on 77 % of sky)
- Completeness for S_nu > 2 Jy
- The sources are 1300 +- 100 in the sky >400!
- Underestimation of the sources contribution in the final power spectrum of the CMB fluctuations by a factor 2.
- A probable reason – a confusion in antenna beams.(1deg) and signal/noise (933src at 3sigma in L-C+)
- We could observe 2/3 of the sources for ~ 2-3 weeks with RATAN-600 before the Planck launch (2008)