Snapshot VLBI Mapping of Variable Extragalactic Sources at 327 MHz

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Abstract. We present results of the Global MkII VLBI snapshot observations of a sample of 16 low frequency variable sources. The sample contains 1 radio galaxy, 9 quasars, 4 BL Lacs, and 2 unidentified sources. The sources were selected from a ten-year flux monitoring at Arecibo Observatory at 1400, 880, 606, 430, and 318 MHz. The VLBI data show clear evidence of significant scattering at baselines of 2–6 Mλ and longer. The obtained results enable us to look for possible correlations between flux variability and the fine structure of sources.

The distinction between an intrinsic nature of the variability of extragalactic sources and propagation phenomena remains of interest. A low frequency variability monitoring program has been underway at the Arecibo Observatory and the National Radio Astronomy Observatory since 1980 (MITCHELL *et al.*, 1993). In this program 33 extragalactic sources taken from complete samples searched for variability at 318 MHz were monitored at bi-monthly intervals at five frequencies (1400, 880, 606, 430, and 318 MHz). The NRAO 300-ft telescope was used until 1985 for the 1400 and 880 MHz observations. Sixteen of the most "active" sources from the low frequency monitoring program were selected for VLBI observations at 327 MHz to search for structure on the scale of centiarcseconds (Table 1).

The observations were carried out with the Global VLBI network in March 1986 with the telescopes Fort Davis, Green Bank, Haystack, Jodrell Bank, Maryland Point, OVRO, Simeiz, Torun, WSRT (phased array), VLA (phased array). Data were correlated on the Mark 2 correlator at MPIfR in Bonn, Germany. Postprocessing of data was done with the Caltech VLBI package, including the recently developed DIFMAP program, implemented on a Sun workstation operated under UNIX.

In comparison to higher frequencies the resolution loss at 327 MHz is counterbalanced by the typically larger angular size of structure patterns at lower frequencies. Propagation effects are also more noticeable at longer wavelengths, as

Table 1. The sample for the VLBI study of low frequency variable sources.

Source	RA (1950)[a]	Decl. (1950)[a]	Type	z^{b}	S^{c}_{318} [Jy]
0116+319 4C31.04	01 16 47.425	+31 55 05.78	G	0.059	4.10
0235+164	02 35 52.619	+16 24 03.88	B	0.940	1.49
0333+321 NRAO140	03 33 22.385	+32 08 36.50	Q	1.263	3.30
0723−008	07 23 17.854	−00 48 55.45	B	0.127	3.43
0735+178	07 35 14.109	+17 49 08.88	B	>0.424	2.17
0851+202 OJ287	08 51 57.311	+20 17 57.34	B	0.306	1.19
1055+018 4C01.28	10 55 55.320	+01 50 00.44	Q	0.888	5.40
1117+146 4C14.41	11 17 50.97	+14 37 21.1			3.91
1422+202	14 22 37.5	+20 13 58	Q	0.871	5.66
1611+343 DA406	16 11 47.916	+34 20 19.8	Q	1.401	3.29
1633+382 4C38.41	16 33 30.625	+38 14 09.98	Q	1.814	2.35
1901+319 3C395	19 01 02.320	+31 55 13.84	Q	0.635	6.41
2050+363 DA529	20 50 54.3	+36 23 58			3.19
2145+067 4C06.69	21 45 36.566	+06 43 3.18	Q	0.990	3.68
2230+114 CTA102	22 30 07.812	+11 28 22.7	Q	1.037	7.52
2251+158 3C454.3	22 51 29.521	+15 52 54.31	Q	0.859	12.13

[a]Coordinates from MORABITO et al. (1982, 1985), and PERLEY (1982).
[b]Redshifts from VÉRON-CETTY and VÉRON (1991).
[c]Weighted mean flux density at 318 MHz obtained by the authors at the Arecibo Observatory.

the degree of scattering of radiation in an ionized medium is proportional to the square of the wavelength.

As a general statement we note, that the data show clear evidence of significant scattering at baselines 2–6 Mλ and longer. Figure 1 presents VLBI maps of some sources discussed here. The typical dynamical range of the maps is (50–100):1. Obtained structures will enable us:

- to study the dependence "source size-variability"
- to pick the most interesting sources for further studies with higher dynamical range and other frequencies.

Figure 2 shows the minimal apparent angular size of detected structure component as a function of the source galactic latitude. The theoretical prediction is calculated for the Kolmogorov spectrum of the electron density distribution according to RICKETT (1986) and BLANDFORD et al. (1986). Obviously the apparent sizes bounds the theoretical curve. This fact may have serious interpretational consequences and will be analized elsewhere.

Figure 3 plots the percent RMS of the source flux density variability at 318 MHz versus the apparent sizes of VLBI components at 327 MHz. RMS data were obtained from observations at Arecibo during 10-15 epochs for each source (MITCHELL et al., 1993). This plot is in agreement with the previous one (Fig. 2), indicating the non-

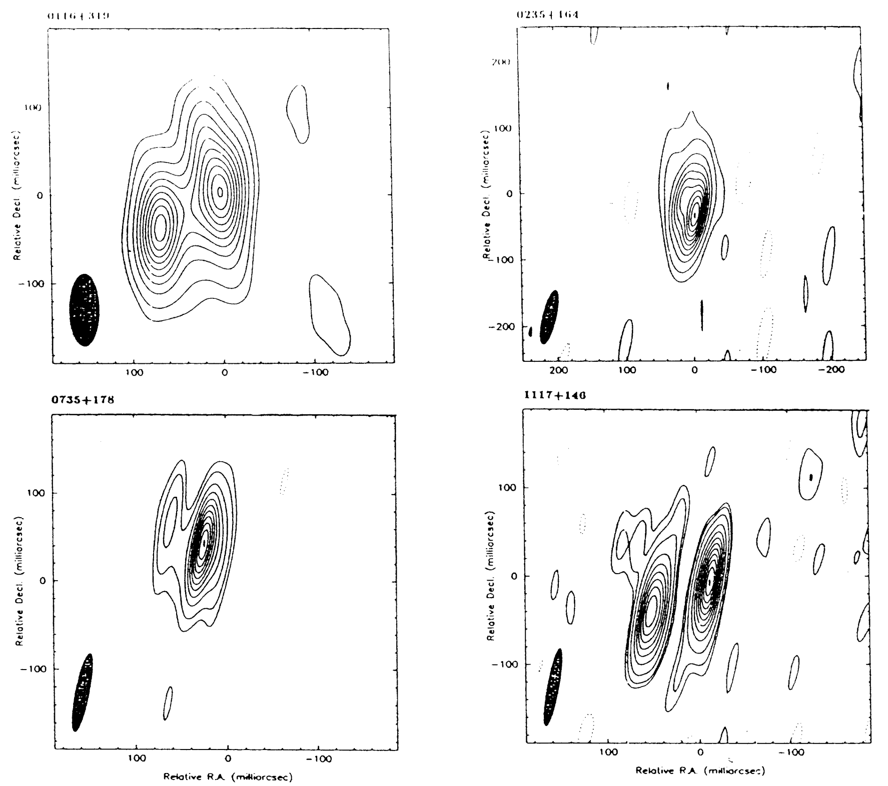

Fig. 1. Maps of sources 0116 + 319, 0235 + 164, 0735 + 178, and 1117 + 146. Contour levels are –5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 99% of peak brightness of 1.261, 0.369, 0.852, and 0.941 Jy/beam respectively.

point-like intrinsic structure of almost all observed sources.

We note that one of these nine sources, 1117 + 146, is of special interest. Comparison of our map at 327 MHz (see Fig. 1) and the map obtained by PADRIELLI *et al.* (1991) at 608 MHz shows almost the same structure dominated by two clear components. Direct estimation of their spectral indices gives values about –0.4 for both components. The angular distance between components is approximately 70 mas. The source looks too large to be classified as a compact double (PEARSON and READHEAD, 1988) but the spectra of their components are very unlike those of "normal" (i.e. CygA-like) extended double extragalactic radio sources.

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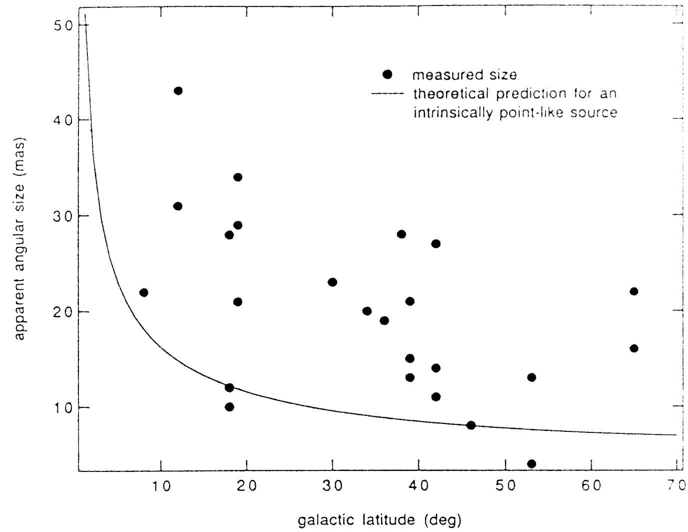

Fig. 2. The minimal apparent angular size of detected structure components as a function of the source galactic latitude. The theoretical prediction is calculated for the Kolmogorov spectrum of the electron density distribution according to RICKETT (1986) and BLANDFORD *et al.* (1986).

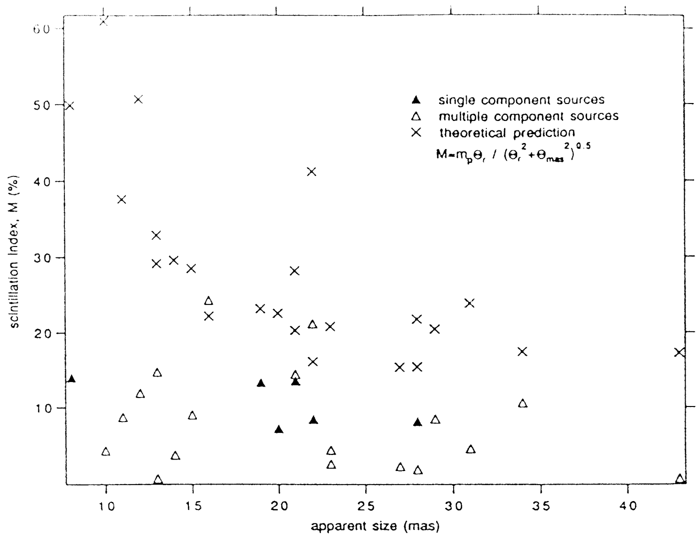

Fig. 3. The percent RMS of the source flux density variability at 318 MHz versus the apparent sizes of VLBI components at 327 MHz. The theoretical prediction is calculated for the Kolmogorov spectrum of the electron density distribution according to RICKETT (1986). Θ_r is the scatter-broadened angular size of a point source, $m_p = 50\%$ (as known from observations of pulsars), Θ_{mas} is the intrinsic source size.

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