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LFVN observations of active galactic nuclei

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Abstract. In November 1999 we carried out VLBI observations of several quasars and BL Lacertae objects at 1.66 GHz. Six antennas participated in the experiment (Bear Lakes, Svetloe, Pushchino, Noto, HartRAO, and Seshan). The results for six sources (0420+022, 0420−014, 1308+326, 1345+125, 1803+784, and DA 193) are presented and discussed.

1. Introduction

LFVN project was started in 1996 (Molotov et al. 2002) having the purpose to arrange the international VLBI cooperation with participation of former Soviet Union radio telescopes.

At first stages, LFVN was developing dynamically and successfully. 13 antennas in different countries were equipped with new receiving-recording radio astronomy apparatuses: Bear Lakes RT-64, Pushchino RT-22, Zimenki RT-15, St. Pustyn RT-14 (Russia), Evpatoria RT-70 and Simeiz RT-22 (Ukraine), Ventspils RT-32 (Latvia), Noto RT-32 (Italy), Torun RT-14 (Poland), Ooty 500x30 parabolic cylinder of ORT and Pune RT-45 of GMRT (India), Urumqi RT-25 and Shanghai RT-25 (China).

The 18 VLBI experiments were carried out using various combinations of radio telescopes in Canada, China, England, India, Italy, Japan, Latvia, Poland, Russia, South Africa, Ukraine and USA. LFVN had two main directions of works: (i) a subsystem with use of obsolete, but very cheap in operations, Mk-2 recording terminal for investigations of solar wind, solar spikes and radar research of Earth group planets, close asteroids and space debris objects; (ii) a subsystem with use of more modern S2 Canadian recording terminal (Cannon et al. 1997) for the investigations of active galactic nuclei (AGN), solar wind, OH-masers, active stars. At first, LFVN experiments were processed by Block II JPL/Caltech Mk-2 correlator in USA, then by the Penticton DRAO S2 correlator in Canada (Carlson et al. 1999). Step by step, LFVN acquired all necessary signs of VLBI network - technical, scheduling and post-processing groups, "own" Mk-2 correlator NIRFI-3 in N. Novgorod, Russia. LFVN results on AGN, solar wind, spikes, radar researches, and technical developments were published in more than 100 papers in open scientific literature. The fully steerable NIS radio telescopes participated in LFVN experiments and few NIS antennas had first VLBI fringes exactly under this work. Two largest NIS radio telescopes: Bear Lakes RT-64 and Evpatoria RT-70 are operated under LFVN activity mainly. St. Pustyn RT-14 is operated only under LFVN activity. LFVN is a single European instrument that regularly carries out the VLBI radar observations of the Solar system bodies.

The three VLBI sessions with participation of six telescopes each were mainly devoted to the research of AGN. The sample of GPS sources and BL Lacs were observed.

2. Observations

The observations (INTAS 99.4 experiment) were made in November 1999 (1999.91) at 1.66 GHz using a global VLBI array of six antennas listed in Table 1. The north-south resolution provided by these observations is substantially improved due to the use of the southern antenna in South Africa. The data were recorded using the S2 system, and all data were subsequently correlated using the Penticton S2 correlator. The data were calibrated and imaged in the NRAO AIPS package using the standard technique. In addition to the results reported below on the observations of active galactic nuclei, the experiment had some more targets to explore: solar wind study, an OH-maser monitoring, and observations of a radiostar Lambda And.

3. Results

Results for the six sources are presented below. Models for the source structures were derived modelling the complex I visibilities that come from the hybrid mapping process with circular Gaussian components, as described by Roberts et al. (1987). The model fits are shown in Table 2. We denote distance from the core by r and the VLBI jet direction by φ. The errors of the separations of jet components from the core are formal 1σ errors, corresponding to an increase in the best-fitting χ^2 by unity. The smallest of these formal errors underestimate the ac-

Table 1. Antennas and their characteritics at 1.66 GHz.

Radio telescope	Diameter (m)	SEFD[a] (Jy)
Svetloe (Russia)	32	394
Bear Lakes (Russia)	64	156
Pushchino (Russia)	22	1585
HartRAO (South Africa)	26	515
Noto (Italy)	32	1070
SESHAN25 (China)	25	1250

[a] System equivalent flux density

Table 2. Source models.

$I \pm \sigma_I$, mJy	$r \pm \sigma_r$, mas	$\varphi \pm \sigma_\varphi$, deg	$\theta \pm \sigma_\theta$, mas
0420−022			
1309 ± 42	…	…	< 0.5
110 ± 23	1.78 ± 0.12	159 ± 5.5	< 0.5
30 ± 4	7.06 ± 0.22	−176 ± 0.7	< 0.5
20 ± 5	12.59 ± 0.38	−176 ± 0.8	< 0.5
0420+022			
772 ± 28	…	…	< 0.5
52 ± 9	1.78 ± 0.14	−41 ± 4.6	< 0.5
61 ± 8	2.31 ± 0.21	−86 ± 4.8	0.63 ± 0.25
73 ± 8	4.53 ± 0.25	−93 ± 3.3	< 0.64
DA 193			
1872 ± 8	…	…	0.55 ± 0.05
1308+326			
1389 ± 44	…	…	1.11 ± 0.10
925 ± 68	2.33 ± 0.13	35 ± 3.1	1.97 ± 0.23
299 ± 60	4.99 ± 0.15	54 ± 1.8	1.45 ± 0.61
1803+784			
1459 ± 87	…	…	1.10 ± 0.26
80 ± 16	2.80 ± 0.23	−100 ± 4.1	0.89 ± 0.31
322 ± 31	4.83 ± 0.46	−104 ± 5.2	1.99 ± 0.88
36 ± 9	26.24 ± 0.87	−103 ± 1.2	1.18 ± 0.35

tual errrors; realisticaly, the smallest 1σ errors are probably no less than 0.3 mas at at 1.6 GHz.

Fig. 1 shows *u*-*v* plane coverage of BL Lac object 1803+784. VLBI image of this source is presented on Fig. 2.

Using our model and a model taken by Hong et al. (1999) for variable and strongly polarised quasar 0420−022 (z=0.915) at epoch 1995.83 we were able to estimate an apparent speed of the jet component located at 1.78 mas from the VLBI core. Assuming $H_0 = 70h$ km s^{-1} Mpc^{-1} and $q_0 = 0.5$ we obtained $\beta_{app} = 1.3h^{-1}$.

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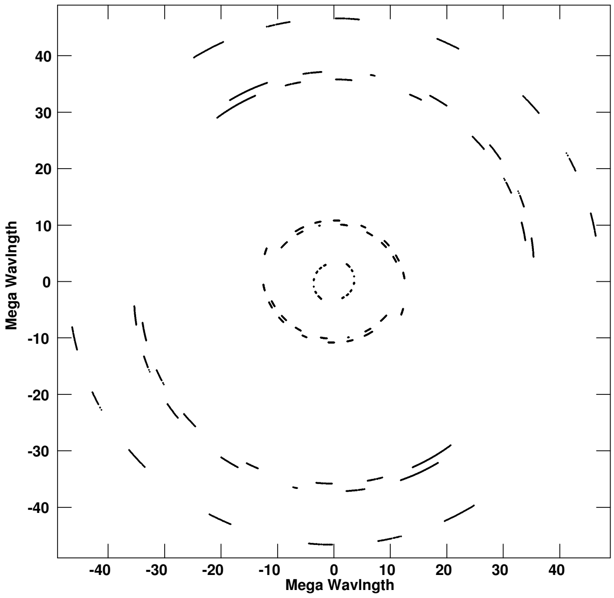

Fig. 1. Coverage of the *u*-*v* plane at 1.66 GHz for LFVN observations of 1803+784 at epoch 1999.91.

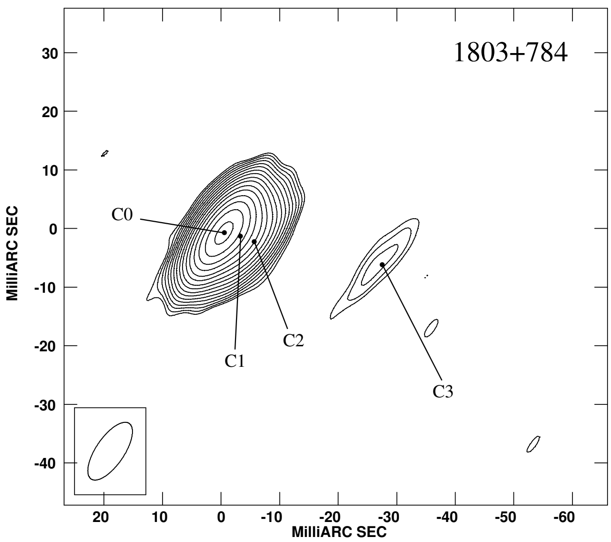

Fig. 2. LFVN image of 1803+784 at 1.66 GHz with bottom contour at 0.5% of the peak of 1.48 Jy/beam. Positive contour levels increase by a factor of $\sqrt{2}$.

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