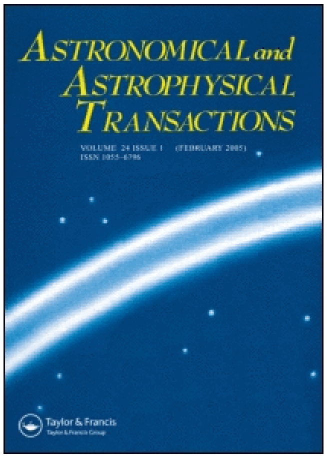

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GIANT METRE-WAVE RADIO TELESCOPE 615 MHz OBSERVATIONS OF MICROQUASAR CANDIDATES

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Observations at 245 and 615 MHz were carried out in July–August 2002 with the Indian low-frequency array Giant Metre-wave Radio Telescope (GMRT). 26 microquasar candidates were included in the source list. The radio structures of these sources have been obtained for many of these. Some sources (MCQC J0014+58 and MCQC J0824-30) demonstrate the two-sided radio jet as a GMRT scale and could be considered as promising microquasar candidates. This paper contains a description of the processing method used for 615 MHz data. This processing has been carried out with the software Astro Space Locator (ASL for Windows).

KEYWORDS: GMRT, microquasar, Astro Space Locator

1 INTRODUCTION

A microquasar is an active star system consisting of a donor star, a compact relativistic object (neutron star or black hole) and an accretion disc feeding on a substance of the donor star. In fact, this is a mini-model of an active galactic nucleus (AGN). Properties of this model in different frequency ranges (radio, optics and X-ray) at different stages of activity are important for understanding non-stationary astrophysical processes. Only 16 objects of this type are known at present in our Galaxy, and each of these has its own individual peculiarities. The discovery of new objects of this type could allow us to comprehend the nature of their activity in more detail and to assist us to understand the essence of the much more powerful and long-time processes in accretion discs of massive and super-massive black holes and AGNs. A list of microquasar candidates was created according to observational data from the X-ray satellite ROSAT. A number of point sources with a certain flux ratio in the hard and soft

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X-ray range were selected and identified roughly with point sources of the Greek Bank 6 centimetre catalog (GB6), Parkes–MIT–NRAO catalog (PMN) and NRAO VLA Sky Survey (NVSS) catalogues for 1.4 and 4.8 GHz frequency ranges. Then the coordinates of these sources were defined more precisely from the observations in the aperture synthesis systems, such as the Australia Telescope Compact Array (ATCA) and the Very Large Array (VLA) radio telescope. Thus, a list of the 26 microquasar candidates was established. The next step in these investigations is the observation of selected sources at low frequency to reveal their arcsecond structure. An Indian array, the Giant Metre-wave Radio Telescope (GMRT), was used for this observation.

2 DESCRIPTION OF THE EXPERIMENT

The survey was carried out on 29 July 2002 and then was repeated on 4 August 2002. 3C147 and 3C286 were used as amplitude calibrators. Table 1 contains their coordinates and flux density values.

30 GMRT 45 m antennae were involved into these observations. The maximum baseline length is approximately 25 km. Thus, the resolution is equal to 4″ for 615 MHz frequency range. Correlation was carried out in the GMRT correlator. The final flexible image transport system file contains one frequency band of 8 MHz width.

A number of bright sources were used to make a preliminary phase calibration. Table 2 contains the list of phase calibrators.

Table 3 contains the list of 26 microquasar candidates that were observed.

Table 1. Amplitude calibrators.

		Right ascension (2000)			*Declination (2000)*			
	Name	*(h)*	*(m)*	*(s)*	*(∘)*	*(′)*	*(″)*	*615 MHz flux density (Jy)*
1	3C147	05	42	36.14	+49	51	07.23	38.03
2	3C286	13	31	08.29	+30	30	32.96	20.8

Table 2. Phase calibrators.

		Right ascension (2000)			*Declination (2000)*		
	Name	*(h)*	*(m)*	*(s)*	*(∘)*	*(′)*	*(″)*
1	0432+416	04	32	44.90	+41	38	39.80
2	0521+166	05	21	16.80	+16	38	32.70
3	0837−198	08	37	15.90	−19	52	19.10
4	1822−096	18	22	37.30	−09	38	51.60
5	1830−360	18	31	09.50	−36	02	27.40
6	2052+365	20	52	58.90	+36	36	06.50
7	2350+646	23	51	03.10	+64	40	50.20

Table 3. List of microquasar candidates observed.

		Right ascension (2000)			*Declination (2000)*		
	Name	*(h)*	*(m)*	*(s)*	*(∘)*	*(′)*	*(″)*
1	MCQC J0014+58	00	14	42.13	+58	02	01.21
2	MCQC J0131+61	01	31	07.16	+61	20	33.00
3	MCQC J0342+69	03	42	18.93	+69	29	16.97
4	MCQC J0414+28	04	14	12.92	+28	12	12.21
5	MCQC J0501+30	05	01	41.18	+30	48	26.01
6	MCQC J0533+14	05	33	35.93	+14	51	15.65
7	MCQC J0557−06	05	57	16.84	−06	17	06.87
8	MCQC J0616−04	06	16	05.48	−04	32	59.63
9	MCQC J0620+26	06	20	40.06	+26	43	31.90
10	MCQC J0621+17	06	21	47.75	+17	47	35.08
11	MCQC J0719−40	07	19	39.19	−40	11	47.02
12	MCQC J0722−07	07	22	59.68	−07	31	34.79
13	MCQC J0804−27	08	04	51.44	−27	49	11.33
14	MCQC J0824−30	08	24	03.48	−30	20	37.15
15	MCQC J0858−31	08	58	02.90	−31	30	37.78
16	MCQC J1626−33	16	26	23.08	−33	29	33.62
17	MCQC J1628−41	16	28	47.28	−41	52	39.16
18	MCQC J1655−22	16	55	17.95	−22	40	45.43
19	MCQC J1757−41	17	57	17.66	−41	49	18.76
20	MCQC J1850+26	18	50	24.03	+26	31	53.67
21	MCQC J1925+37	19	25	19.06	+37	05	35.85
22	MCQC J1932+34	19	32	27.24	+34	53	14.78
23	MCQC J1942+10	19	42	47.48	+10	33	27.11
24	MCQC J2026+33	20	26	58.45	+33	43	08.73
25	MCQC J2113+40	21	13	43.26	+40	45	13.38
26	MCQC J2300+40	23	00	12.37	+40	52	24.70

3 METHOD OF DATA PROCESSING

All sources observed seem to be quite weak in the 615 MHz frequency range. Hence, we have to solve the problem of fringe detection. A method of very-long-basline interferometry phase referencing was used. See the paper by Beasley and Conway (1995) to obtain a detailed description of this method. Sources from Table 2 were used to estimate the primary values of the delay and fringe rate. We obtained a phase calibrator with minimum separation from the target source.

After the phase-referencing procedure had been successfully finished, we had to use the next phase calibration procedure (global fringe fitting) to estimate values of the delay and fringe rate more precisely and to make a second correction to the visibility phase. Then, we could average the data over the frequency range and also over time. These averaged data were been amplitude calibrated with sources from Table 1.

Thus, the method of GMRT low-frequency data processing that was used consists of the following stages :

(a) phase referencing of initial data with the phase calibrator from Table 2;
(b) global fringe fitting (the second stage of phase calibration);
(c) averaging of data over time and frequency;
(d) Amplitude calibration of data with the amplitude calibration from Table 1;
(e) editing of data and final time averaging if necessary.

4 RESULTS OF DATA PROCESSING

Table 4 contains the estimated values of 615 MHz flux density for 12 of 26 microquasar candidates observed.

615 MHz images of the four objects observed are shown in Figures 1–4. Two of these (MCQC J0131+61 and MCQC J0722−07) demonstrate a one-sided jet. The two others (MCQC J0014+58 and MCQC J0824−30) demonstrate a two-sided jet and are promising microquasar candidates.

Table 4. The measured flux density values.

	Name	*F (615) MHz (Jy)*
1	MCQC J0014+58	0.20
2	MCQC J0131+61	0.16
3	MCQC J0342+69	0.11
4	MCQC J0414+28	0.08
5	MCQC J0501+30	0.25
6	MCQC J0533+14	0.22
7	MCQC J0557−06	0.19
8	MCQC J0616−04	0.07
9	MCQC J0719−40	0.18
10	MCQC J0722−07	0.40
11	MCQC J0804−27	0.70
12	MCQC J0824−30	0.20

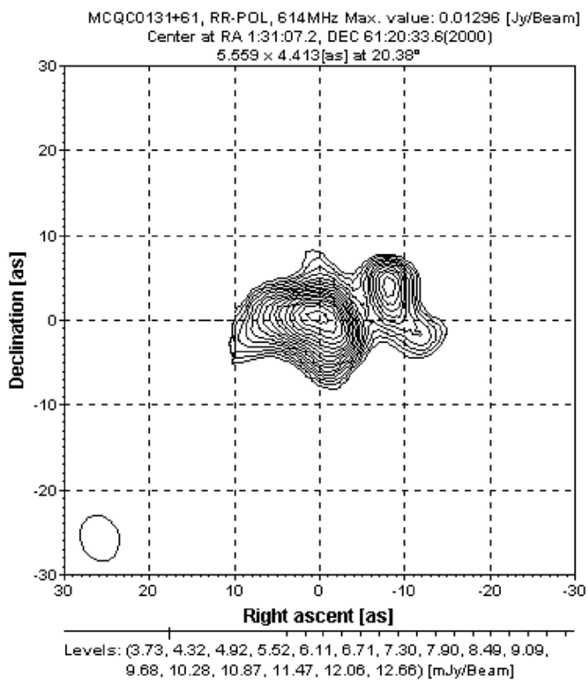

Figure 1. 615 MHz reconstructed image of MCQC J0131+61.

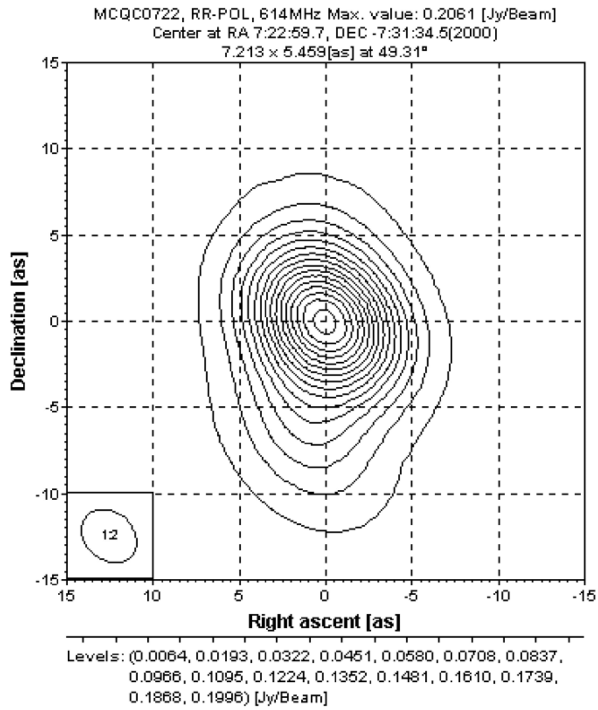

Figure 2. **615 MHz reconstructed image of MCQC J0722−07.**

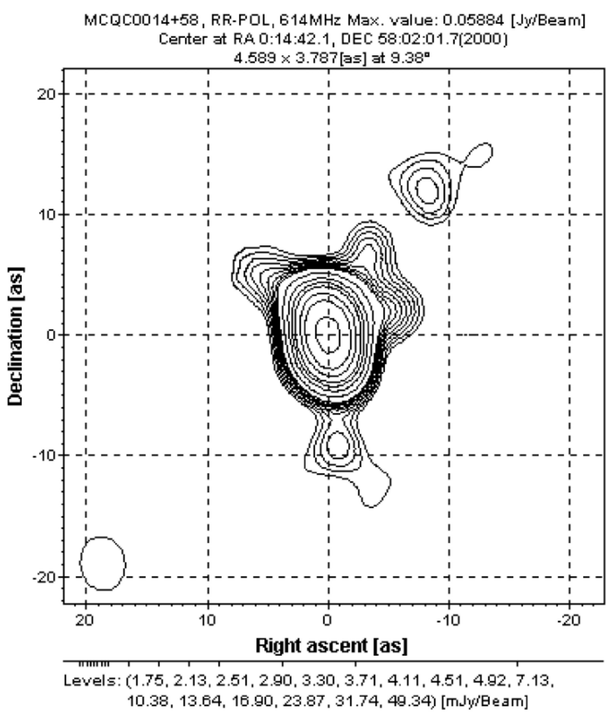

Figure 3. **615 MHz reconstructed image of MCQC J0014+58.**

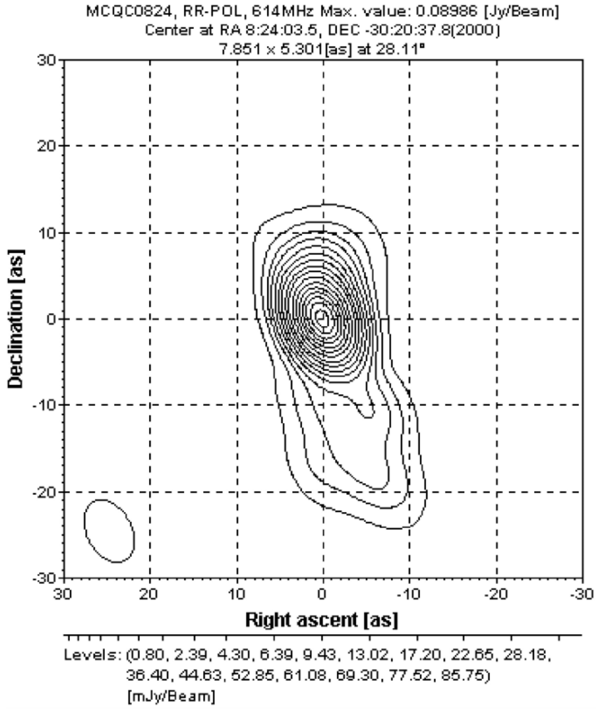

Figure 4. 615 MHz reconstructed image of MCQC J0824−30.

5 CONCLUSIONS

26 star-like objects were selected as microquasar candidates and were observed with the Indian array GMRT. A method of phase referencing was developed and implemented into the software Astro Space Locator (ASL for Windows) (Chuprikov, 2002) to carry out the post-processing of data obtained. Images of some objects observed are reconstructed.

We still have some serious problems with data in another frequency range, 245 MHz, that were also used in this experiment. Our goal is to improve the method of phase referencing in order to process these data too. These investigations will be continued in the near future.

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