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Pilot 1.3-cm IDV Observation of Two Dozens of AGNs at Urumqi

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Abstract. We carried out a pilot 1.3-cm IDV observations of two dozens of AGNs at Urumqi from 23 to 25 November 2011. Six sources, namely J0136 + 4751, J0217 + 0144, J1058 + 0133, J1751 + 0939, J1833 − 2103 and DA193 were detected as IDV sources at a 99% confidence level (about 3σ level). The weather was fine during the observation period, but the system noise after calibration remained which could be due to the data sampled are relatively sparse for each source in the observations.

Key words. Galaxies: active—radio continuum—jets.

1. Introduction

The Intra-Day Variability (IDV) of flat spectrum compact radio source was discovered 25 years ago (Heeschen *et al.* 1987). The physical cause of the variability is still controversial. There are two explanations: one is intrinsic effect (Qian *et al.* 1991) and the other is extrinsic effect, e.g. the interstellar scintillation in our galaxy (Liu *et al.* 2012). For the first explanation, it would lead to very high-brightness temperature of the emission component and causes a serious violation of the inverse Compton limit of 10^{12} K (Kellermann & Pauliny-Toth 1969).

We have carried out IDV observations for several years at 6 cm band at Urumqi (Liu *et al.* 2012). Now we have a new 1.3 cm receiver and we want to use it for IDV observations, the higher frequency IDV observations would help us obtain more information on intrinsic variabilities of AGNs.

2. Observation and data reduction

From 23 to 25 November 2011, we carried out a pilot 1.3-cm IDV observations for two dozens of AGNs at Urumqi. These sources were selected from relatively strong sources at 1.3 cm. The source intensity was obtained by using cross-scans in azimuth and elevation, four times in each coordinate. This enabled us to check the pointing offsets in both co-ordinates. After applying an amplitude correction for pointing errors, we corrected the amplitudes for the elevation-dependent antenna gain and the remaining systematic time-dependent effect by using several secondary

Table 1. The observational information and result, $m_0 = 1.58\%$.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Source	Scans	$\bar{S}$ [Jy]	rms	m [%]	Y [%]	χ_r^2	Probability
3C123	18	3.258	0.131	4.03	11.12	1.930	1.1916E-02
3C273	15	17.840	0.280	1.57	0.00	0.384	9.7975E-01
3C274	11	18.307	0.163	0.89	0.00	0.111	9.9972E-01
3C279	13	28.819	0.460	1.60	0.71	0.378	9.7182E-01
3C286	12	2.555	0.039	1.54	0.00	0.197	9.9782E-01
3C345	15	5.554	0.145	2.62	6.27	0.919	5.3737E-01
3C446	11	3.568	0.099	2.78	6.86	1.188	2.9313E-01
3C454.3	17	9.013	0.201	2.23	4.73	0.634	8.5887E-01
3C84	15	27.230	0.419	1.54	0.00	0.316	9.9229E-01
4C39.25	18	8.869	0.162	1.83	2.76	0.398	9.8633E-01
DA193	17	2.690	0.113	4.21	11.70	2.003	9.8434E-03
DR21	12	17.724	0.297	1.68	1.71	0.389	9.6112E-01
J0136+4751	19	2.262	0.102	4.50	12.64	2.153	3.0771E-03
J0217+0144	14	1.538	0.082	5.35	15.34	2.318	4.4991E-03
J0423−0120	14	5.746	0.120	2.09	4.12	0.695	7.7073E-01
J0646+4451	18	2.237	0.089	3.98	10.96	1.530	7.4209E-02
J0730−1141	11	3.075	0.122	3.96	10.90	1.983	3.0924E-02
J1058+0133	14	5.394	0.211	3.91	10.73	2.263	5.6989E-03
J1751+0939	15	2.273	0.104	4.58	12.90	2.476	1.6471E-03
J1833−2103	9	5.687	0.281	4.94	14.04	3.734	2.2236E-04
J2123+0535	14	1.375	0.068	4.93	14.03	1.801	3.6965E-02
J2136+0041	15	5.715	0.198	3.46	9.23	1.238	2.3872E-01
J2148+0657	17	3.656	0.140	3.84	10.51	0.251	9.9887E-01
NGC7027	17	5.434	0.089	1.63	1.26	0.251	9.9887E-01
NRAO150	20	8.421	0.287	3.41	9.07	1.597	4.7698E-02
OJ287	19	5.957	0.192	3.22	8.42	1.206	2.4547E-01

calibrators (3C273, 3C274, 3C84, 4C39.25, and DR21) and two primary calibrators. Finally, we converted our measurements to absolute flux density with the frequently observed two primary calibrators (3C286 and NGC7027).

The quantities we used to evaluate the significance and amplitude of the variability are the reduced χ^2-test, the rms flux density over mean flux density (the so-called modulation index, m), and the relative variability amplitude Y, which is corrected for noise-bias, defined as $Y = 3\sqrt{(m^2 - m_0^2)}$, where m_0 is the mean modulation index of all calibrators, describing the statistical accuracy during the observations. In Table 1, we list the observation information and the results of the observations. The columns are: (1) source name, (2) the effective number of data points (NP), (3) and (4) the source average flux density and rms flux density, (5) the modulation index of variability, (6) the relative variability amplitude of source, (7) the reduced χ^2, and (8) the probability of non-variability.

3. Variability analysis and discussion

From the result of 1.3-cm IDV observations in Table 1, the χ^2-tests suggest that six sources show IDV at a confidence level of ≥99%. They are J0136 + 4751, J0217 + 0144, J1058 + 0133, J1751 + 0939, J1833 − 2103 and DA193. Except the source J1833 − 2103, which is a gravitational lens system, the other five sources are compact core-dominated blazars in the VLBI maps from available literatures.

There are several factors that could influence the error budget of the result: weather, source strength, data sampling of each source, and the stability of the receiver etc. Weather was fine during the observation, so it did not influence the result. All the calibrators used were relatively strong sources, so they did not cause the calibration problem. The Pilot 1.3-cm IDV session observed 26 sources in total, so the relatively large system noise ($m_0 = 1.58\%$) might have been due to too many sources observed in this session which led to less points for each source in future. If this really is the case, we will change the observing strategy to increase the data sampling for each source. Also, in future we will try to investigate if there is any instability in the 1.3-cm receiver, which might contribute to the system noise.

In summary, the Pilot 1.3-cm IDV observations at Urumqi found 6 IDV sources at a confidence level of 99%. We will continue the 1.3 cm IDV monitoring programme with more time for individual sources in the future.

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