J. Astrophys. Astr. (2014) **35,** 271–274

4.8 GHz Intra-Day Variability of FSRQ 0507 + 179

Lang Cui[1,2,*], Jun Liu[1,2] & Xiang Liu[1,2]
[1]*Xinjiang Astronomical Observatory, Chinese Academy of Sciences, 150 Science 1-Street, Urumqi 830011, China.*
[2]*Key Laboratory of Radio Astronomy, Chinese Academy of Sciences, Nanjing 210008, China.*
[*]*e-mail: cuilang@xao.ac.cn*

Abstract. As one of the targets of many flux monitoring campaigns, FSRQ 0507 + 179 shows various flux variation properties at almost all observing wavelengths, from radio to γ-ray. With Urumqi 25-m telescope, our study on this object is focussed mainly on its radio flux variability, especially the Intra-Day Variability (IDV). We carried out a total of six epochs of IDV observations on 0507 + 179 at 4.8 GHz since March 2010, and found clearly IDV behaviours in all observing sessions and considered it is likely a type-I IDV source by analysing the characteristics and the timescales of the light curves. Additionally, we found 0507 + 179 exhibited some different IDV behaviours after an optical flare.

Key words. Blazars: 0507 + 179—radio—variability—IDV.

1. Introduction

FSRQ 0507 + 179 is a typical blazar with a redshift of 0.416 (Perlman *et al.* 1998) and was detected by γ-ray emission using Fermi/LAT (Abdo *et al.* 2010). 5 GHz VLBI observations reveal a compact core-jet structure with a linear size of ∼100 pc (Cui *et al.* 2011). As one of the targets of many flux monitoring programmes, FSRQ 0507 + 179 shows various flux variation properties at almost all observing wavelengths, from radio to γ-ray. To study the rapid flux variability in 0507 + 179 at radio band, we carried out a total of six IDV sessions at 4.8 GHz with Urumqi 25-m telescope from 2010 to 2012. In the following sections, we will present IDV observations and results, and give a brief summary finally.

2. Observations and results

Ever since September 2008, we carried out a monthly flux monitoring programme on 169 compact radio sources with Urumqi 25-m telescope at 4.8 GHz. As one of the targets of the monitoring plan, 0507 + 179 was found to show significant monthly flux variations during the term of September 2008 to November 2012 (see Fig. 1). To find more rapid flux variability in 0507 + 179, we consequently carried out IDV observations at the same frequency since March 2010.

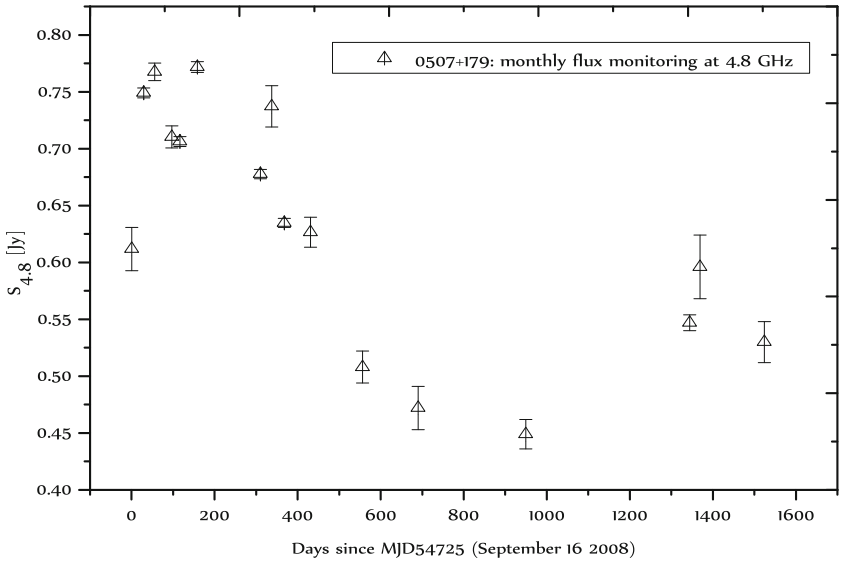

Figure 1. The light curve of monthly flux monitoring on 0507 + 179 at 4.8 GHz.

IDV observations were made in 'cross-scan' mode and each scan consists of 8 sub-scans along azimuth and elevation across the target position. The detailed data calibration procedure can be found in Kraus *et al.* (2003) and Liu *et al.* (2012). The results of IDV observations on 0507 + 179 are given in Table 1, which lists the epoch, the number of scans, mean value of flux density, the standard deviation of flux density, the modulation index of calibrators, the modulation index of 0507 + 179, the relative variability amplitude, the reduced χ^2 and the timescale obtained from structure function (SF) analysis (except the second and fifth ones, which were roughly estimated visually according to the light curves, since there are very few data points to obtain the timescales using SF analysis).

In September 2012, 0507 + 179 was detected using an optical flare by MASTER (Mobile Astronomical System of the Telescope-Robots), and the magnitude increased fast from 18.7 to 16.6, up to the brightest magnitude since January 2009 (Denisenko *et al.* 2012). The last IDV session in Table 1 was arranged after the optical flare to study the possible difference of IDV characteristics compared to that before. Then all the light curves of IDV observations on 0507 + 179 at 4.8 GHz are exhibited epoch by epoch in Fig. 2.

Table 1. The results of IDV observations on 0507 + 179 at 4.8 GHz.

Epoch	N	$\langle S \rangle$ (Jy)	ΔS (Jy)	m_0 (%)	m (%)	Y (%)	χ^2_r	t_{SF} (d)
25.03.2010	15	0.508	0.014	0.80	2.84	8.16	6.982	2.1 ± 0.2
05.08.2010	9	0.472	0.019	0.90	4.11	12.04	8.859	>2.0
21.04.2011	14	0.449	0.013	0.60	2.89	8.49	5.506	2.0 ± 0.1
18.05.2012	13	0.547	0.033	0.60	6.03	18.01	49.273	2.2 ± 0.3
15.06.2012	8	0.596	0.028	0.60	4.77	14.19	18.657	>2.0
15.11.2012	25	0.530	0.018	0.60	3.34	9.85	17.469	1.2 ± 0.2

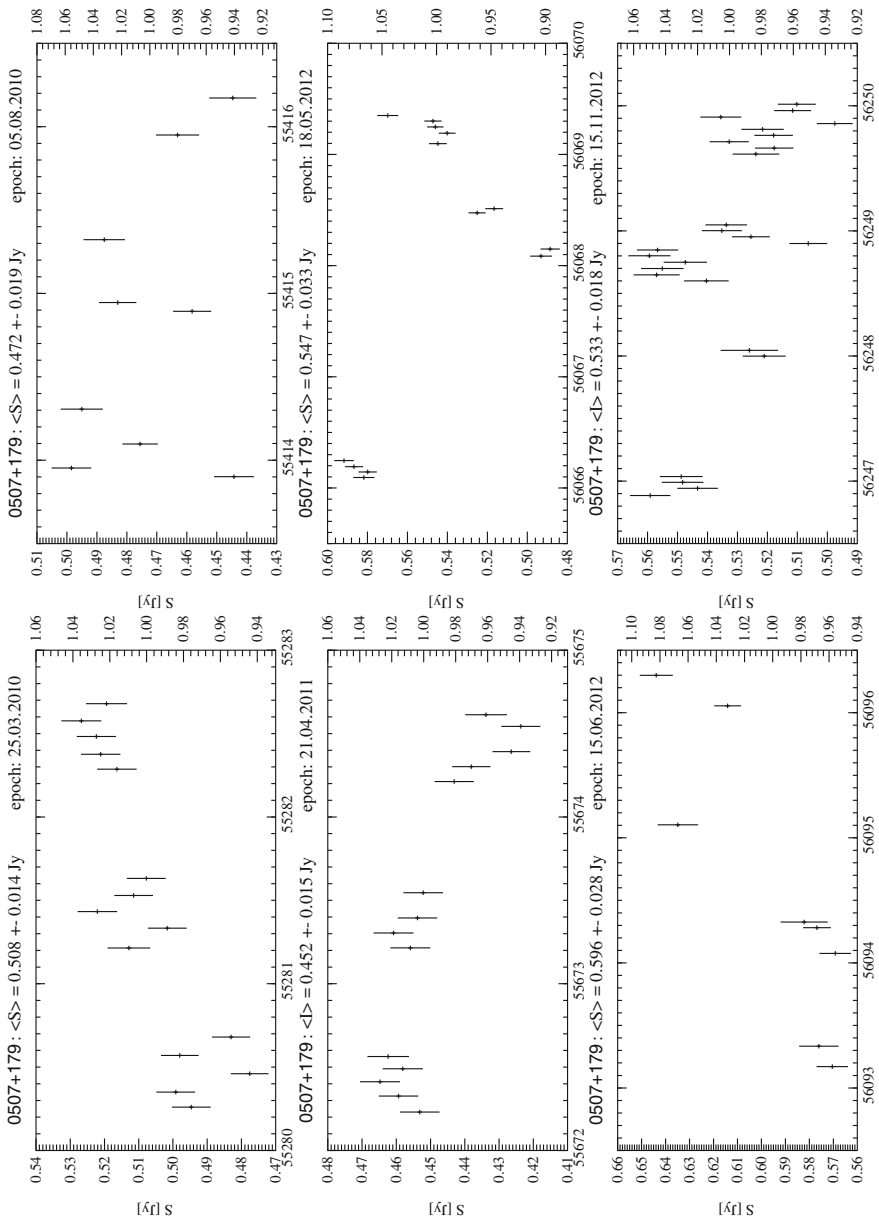

Figure 2. The light curves of IDV observations on 0507 + 179 at 4.8 GHz.

3. Discussion and conclusion

The meanings of the parameters used to evaluate the significance and amplitude of the variability are listed in Table 1, viz. the modulation index m, the relative variability amplitude Y and the reduced chi-square χ^2_r can be found in Quirrenbach *et al.* (2000) and Kraus *et al.* (2003). According to a chi-square-test (Bevington & Robinson 1992) with the reduced χ^2_r listed in Table 1, $0507+179$ shows obvious IDV behaviours in all the observing sessions at a confidence level of over 99.9%. And almost all the light curves except the last session in Fig. 2 show a monotonically increasing or decreasing trend, with the timescales of more than two days, which indicates that $0507+179$ is likely a type-I IDV source (Quirrenbach *et al.* 2000).

To study the possible difference of IDV characteristics in $0507+179$ after the optical flare detected by MASTER, we consequently arranged a new IDV session in the middle of November 2012. Compared to other epochs before the optical flare in Fig. 2, the light curve of the last epoch becomes complex instead of monotonically increasing or decreasing and the timescale becomes shorter than before, as listed in Table 1. This implies that the radio flux variability of $0507+179$ becomes more rapid and it may turn into the high active state after the optical flare. Further radio monitoring of the object is necessary to study its possible radio outburst.

In summary, we carried out six IDV sessions on $0507+179$ with the Urumqi 25-m radio telescope at 4.8 GHz since March 2010 and found that the source exhibits clear IDV behaviours in all the observing sessions. The relatively longer IDV timescales in most of the sessions indicate that the source is likely a type-I IDV source. Additionally, we found that $0507+179$ exhibited some different IDV behaviours and that the flux variability became more rapid after an optical flare.

Acknowledgements

This work is supported by the programme of the Light in China's Western Region (LCWR) under grant XBBS201024, the National Natural Science Foundation of China under grant 11073036 and the 973 Programme of China (2009CB824800).

References

Abdo, A. A., Ackermann, M., Ajello, M., Allafort, A., Antolini, E., Atwood, W. B. *et al.* 2010, *ApJS*, **188**, 405.

Bevington, P. R., Robinson, D. K. 1992, *Data reduction and error analysis for the physical sciences* (New York: McGraw-Hill).

Cui, L., Liu, X., Liu, J. 2011, *JAA*, **32**, 281.

Denisenko, D., Balanutsa, P., Podvoratny, P., Shurpakov, S., Tiurina, E. *et al.* 2012. ATel #4424, http://www.astronomerstelegram.org/.

Kraus, A., Krichbaum, T. P., Wegner, R., Witzel, A., Cimò, G., Quirrenbach, A., Britzen, S., Fuhrmann, L. *et al.* 2003, *A&A*, **401**, 161.

Liu, X., Song, H.-G., Marchili, N., Liu, B.-R., Liu, J., Krichbaum, T. P., Fuhrmann, L., Zensus, J. A. 2012, *A&A*, **543**, A78.

Perlman, E. S., Padovani, P., Giommi, P., Sambruna, R., Jones, L. R., Tzioumis, A., Reynolds, J. 1998, *AJ*, **115**, 1253.

Quirrenbach, A., Kraus, A., Witzel, A., Zensus, J. A., Peng, B., Risse, M., Krichbaum, T. P., Wegner, R., Naundorf, C. E. 2000, *A&AS*, **141**, 221.