Perseus in Sicily: From Black Hole to Cluster Outskirts
Proceedings IAU Symposium No. 342, 2018
K. Asada, E. de Gouveia Dal Pino, M. Giroletti,
H. Nagai & R. Nemmen, eds.

doi:10.1017/S1743921318006026

Multi-frequency monitoring of S5 0716+714

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Abstract. We report preliminary results of long-term multi-frequency monitoring observations of S5 0716+714. We conducted observations at 22 and 43 GHz using Korean VLBI Network (KVN) radio telescopes and combined 8 (UMRAO), 15 (OVRO), 95 (CARMA), and 230 GHz (SMA) data to investigate characteristics of radio flares. We identified six flares (P1-P6) from 2010 November to 2014 June. The magnetic field strengths by assuming a synchrotron self-absorption model are in the range of 9 mG - 11 G in P2, 26 mG - 3G in P3, 3 mG - 38 G in P4, and 1 mG - 8 G in P6.

Keywords. BL Lacertae objects: individual (0716+714), galaxies: active, galaxies: jets

1. Introduction

S5 0716+714 is known as an extremely variable and a bright BL Lacertae-type blazar which has a relativistic jet pointing to the line of sight. Due to the orientation of jet, radio emission is Doppler boosted. The source has been observed complex variability in flux density and polarization emission on time scales of days to months across the entire electromagnetic spectrum from radio to gamma-ray bands (Rani *et al.* 2013; Lee *et al.* 2016; Lee *et al.* 2017a; Lee *et al.* 2017b). In our multi-frequency observations over three years and seven months, six local flares on time scales of weeks to months were detected at all observing frequencies. We investigate the individual flares showing different characteristics of S5 0716+714 to improve our understanding of the emission mechanism.

2. Observations and Data

We performed simultaneous multi-frequency single-dish observations of S5 0716+714 at 22 and 43 GHz using 21-m KVN radio telescopes from 2010 November to 2014 June (MJD 55509 to 56814) with a mean cadence of ∼5 days. We collected multi-frequency data at 8 GHz (UMRAO: University of Michigan Radio Astronomy Observatory) from MJD 55504 to 56060, 15 GHz (OVRO: Owens Valley Radio Observatory), 95 GHz (CARMA:Combined Array for Research in Millimeter-wave Astronomy) from MJD 56157 to 56821, and 230 GHz (SMA:Submillimeter Array).

3. Results

S5 0716+714 shows active flux variability over observing period. Six local flares were detected (see Fig. 1). In order to analyze spectra, we used linear interpolation to the data then we fitted the spectra using synchrotron self-absorption model. We found that the individual flares have different ranges of turnover frequencies (see (c) in Fig. 2). The synchrotron self-absorption magnetic field strengths were estimated using a function in Marscher (1983). We adopted angular size θ of the source as 0.04 mas, Doppler factor δ as 7, following Rani *et al.* (2013), redshift z as 0.127, and b(α) as 2.92 (Lee *et al.* 2017a). The preliminarily estimated magnetic field strengths are in the range of 9 mG - 11 G in

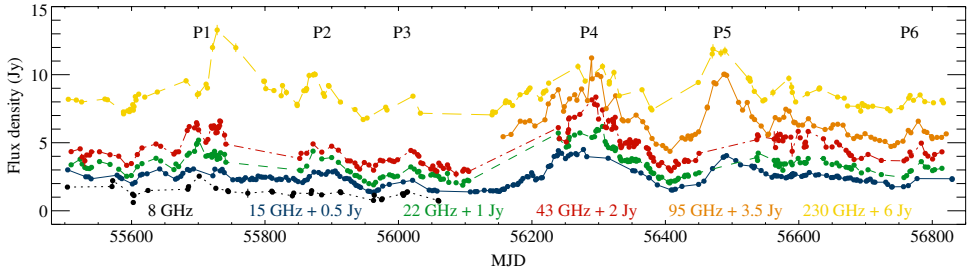

Figure 1. Light curves of S5 0716+714 observed 8 to 230 GHz over 3 years and 7 months from November 2010 to June 2014.

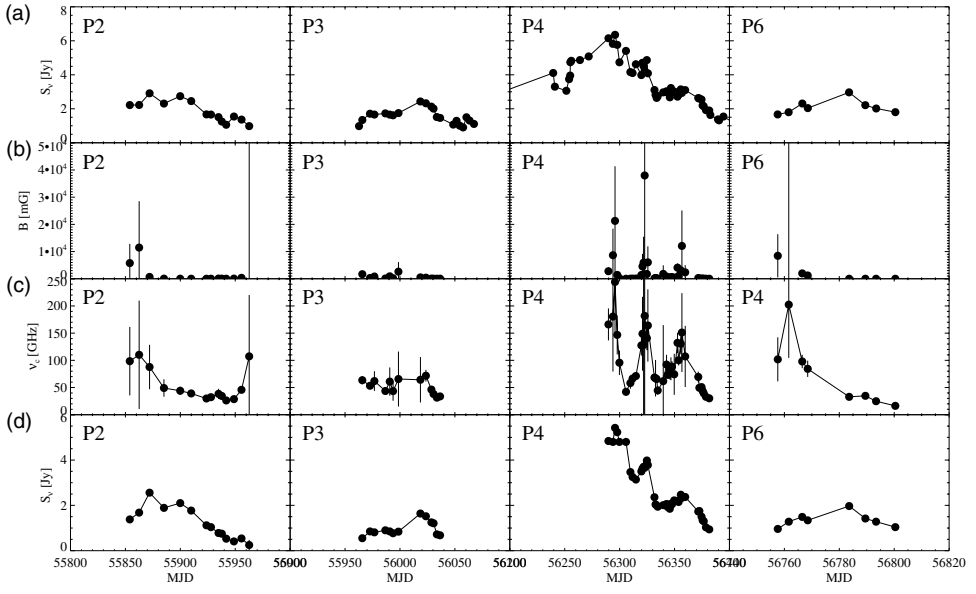

Figure 2. Plots of flux density light curves at 43 GHz (a), B-field (b), turnover frequency ν_c (c), and peak flux density S_m (d) in time domain for P2 to P6

P2, 26 mG - 3G in P3, 3 mG - 38 G in P4, and 1 mG - 8 G in P6. From top to bottom in Fig. 2, flux density light curves at 43 GHz for individual flares, magnetic field strength, turnover frequency, and peak flux density in the time domain are displayed.

Acknowledgement

We are grateful for the support of the National Research Council of Science and Technology, Korea(Project Number EU-16-001). This research has made use of data from the OVRO 40-m monitoring program (Richards, J. L. *et al.* 2011, ApJS, 194, 29) which is supported in part by NASA grants NNX08AW31G, NNX11A043G, and NNX14AQ89G and NSF grants AST-0808050 and AST-1109911. We thank Talvikki Hovatta for providing us the 95 GHz CARMA data obtained through the MARMOT program. The Submillimeter Array is a joint project between the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics and is funded by the Smithsonian Institution and the Academia Sinica.

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https://doi.org/10.1017/S1743921318006026 Published online by Cambridge University Press