Photometric study of a gamma-ray loud narrow line Seyfert 1: PKS 1502+036

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Abstract. We present results of optical monitoring of a gamma-ray loud NLS1 object: PKS 1502+036. The observations were performed with 1.3-m and 2-m telescopes. For the observed period of about 40 days the object didn't show significant variability. We calibrated secondary standards in the field of PKS 1502+036.

Key words: photometry: galaxies – individual: PKS 1502+036

1. Introduction

Narrow line Seyfert 1 (NLS1) are a class of active galactic nuclei (AGN) with relatively narrow ($<\sim$2000 km/s) broad emission lines. The common understanding is that their emission is dominated by an accretion disk, operating at relatively high accretion rate. Recently, however, several NLS1's were detected to emit significantly at gamma-ray energies (Abdo et al. 2009). This high energy emission is commonly attributed to inverse-Compton processes in a relativistic jet, normally associated with blazar-type objects. Thus, gamma-ray loud NLS1's reveal a rare, composite (NLS1/blazar) nature and their study can be of significant importance to understand the physics of AGN.

In this paper we study the short-term (within a month and a half) optical variability of a gamma-ray loud NLS1 objects: PKS1502+036. In general, these AGN are known to show significant optical variations, even on intra-day time scales (e.g. Liu et al. 2010; Foschini et al. 2012; Paliya et al. 2013; Tanaka et al. 2014). Our understanding is that more data will help to discriminate between the jet and disk contributions to the variability, as the "normal" NLS1's are also known to be significantly variable on short time scales (e.g. Semkov et al. 2011).

2. Observations

PKS 1502+036 (z=0.409) was monitored in the optical for a period of about 40 days in the summer of 2012. Observational data were obtained during 11 nights. As the object appears to be quite faint (V$\sim$19 mag), we had to invoke larger telescopes to obtain data of high quality. The instruments used for this study were the 1.3-m Skinakas telescope (Greece), and the 2-m telescope at NAO Rozhen (Bulgaria). The majority of the data were obtained with the 1.3-m at Skinakas observatory, and only one point (JD=2456094.344) – at the 2-m telescope at NAO Rozhen. Standard

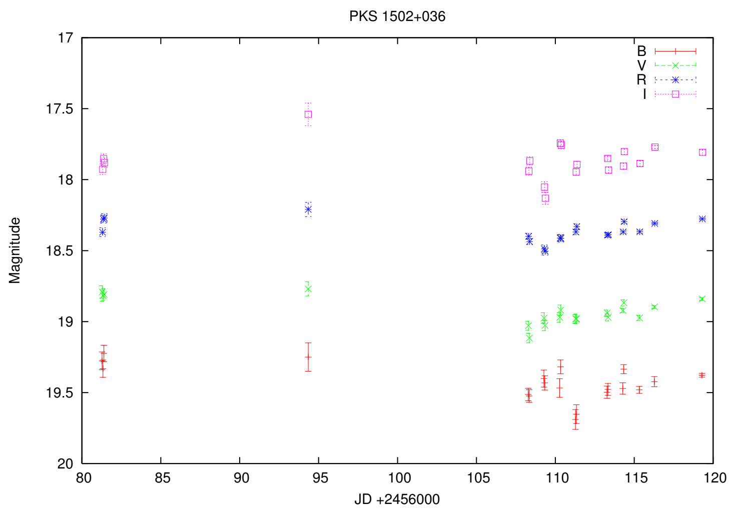

Fig. 1. Light curve of PKS 1502+036 in BVRI filters (2012)

BVRI filters were used; all exposure times were set to 1200 sec. The preliminary reductions were performed using standard ESO-MIDAS routines, they include bias and flat-field corrections. The photometry was done using DAOPHOT (Stetson, 1987) programs running under ESO-MIDAS environment with fixed aperture that was set to 4 arcsec. The typical seeing at Skinakas at the time of observations was 1-1.4 arcsec, that makes aperture radius 2-3 FWHM which is supposed to have highest signal-to-noise ratio and minimal errors (Strigachev, 2009).

3. Results

3.1. Light curve

The light curve of PKS 1502+036 in BVRI colors is shown in Fig. 1. Magnitudes are calibrated comparing to the field stars S1 and S2 (see the next section) and are broadly consistent with the ones from Swift, obtained for the same period (D'Ammando et al. 2013).

The object doesn't show significant variability for the observing period although there are some gradual variations in all filters with a typical amplitude less than 0.3 magnitudes taking into account the photometric errors. These variations are likely due to external photometric errors – the object is rather faint and these errors could be quite large. Also, using different telescopes may include some extra systematic offsets. There is no evidence for rapid (night-to-night) variations too. However, we cannot exclude the possibility that the small variations observed might be possible and real.

Table 1. Secondary standards with errors

Filter	S1	err	S2	err
B	15.61	0.04	19.25	0.08
V	14.90	0.04	18.75	0.04
R	14.46	0.03	18.36	0.03
I	13.94	0.03	17.79	0.09

3.2. Secondary standards

In order to facilitate further monitoring of this object, we calibrated secondary standards in the filed of PKS 1502+036. The standards are indicated on Fig. 2 and their magnitudes and errors are presented in Tab. 1. The errors include the internal photometric and the calibration errors.

The secondary standards were calibrated using standard stars in the field of 3C 454.3 (stars 1,2,3,4) of the GASP adopted standards (The GLAST-AGILE Support Program[1]). For the calibration we used two very stable photometric nights when 3C 454.3 was observed from the Skinakas observatory at very close air-mass as PKS 1502+036.

4. Summary

1. PKS 1502+036 was monitored with 1.3-m and 2-m telescopes during 11 nights over a 40 days period in 2012. The object didn't show significant variability for the observed period although some small gradual variations (<0.3 mag) in all BVRI filters might be possible. This could be an indication either for a rather stable jet in this particular object or for a dominance of the much less variable accretion disk emission in the optical domain. Further studies are encouraged.
2. We calibrated convenient secondary standards in the field of PKS 1502+036 to facilitate further monitoring.

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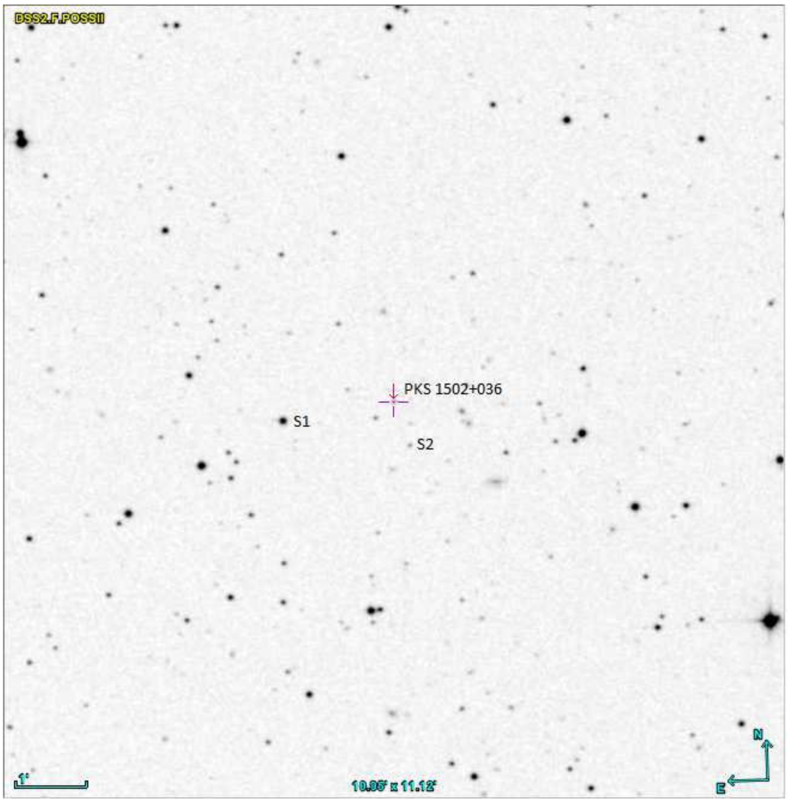

Fig. 2. The field around PKS 1502+036 with the calibrated secondary standards