The Light Curve Variability Period of PKS 0235-618 on Optical R Band

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Keywords: BL Lac object; PKS 0235-618; Jurkevich method; Variability period

Abstract: We present the optical I band light curve of PKS 0235-618 from JD2455365 to JD2456728 by performing the original observation data taken from SMART. Using the Jurkevich method, we found that the light curve variability period of BL Lac PKS 2155-304 on opitical R band is about 298 days.

1. Introduction

Blazar is active galactic nuclei with very intense activity and show very intense high-energy phenomena in all electromagnetic bands. It can be divided into two sub categories: BL Lac and FSRQ. The flat spectrum radio quasar PKS 0235-618 with a redshift *z* of 0.465 is one the BL Lac objects. In 1999, W.Voges. et al[1] discovered that the target is a good X-ray source. In 2004, Ricci. R et al.[2] found that the target is one of the sources of high frequency polarization in Southern Hemisphere. In 2008, Sadler Elaine. M. et al[3] found that PKS 0235-618 is a 95 GHz radio source in an extragalactic Galaxy based on ATCA observations, and the results were published on Monthly Notices of the Royal Astronomical Society. Also in the same year, Healey Stephen. E. et al.[4] found the target to be a good gamma ray source and published the results in The Astrophysical Journal.

In order to study the photodegeneration properties of BL Lac PKS 0235-618 and test its periodicity in optical R-band, the non-uniform observation data of PKS 0235-618 were collected from Smarts website. Jurkevich method was used to find the periodic components of optical R-band photodegeneration curve.

2. Jurkevich method

Jurkevich method is a statistical method[5] based on mean square deviation to deal with non-equidistant data. When we process a sample consisting of N data, the mean, the sum of squares of total deviations and the total variance of the sample are:

$$\overline{\mathrm{x}} = \frac{1}{N}\sum_{i=1}^{N} x_i \tag{1}$$

$$V^2 = \sum_{i=1}^{N} x_i^{\,2} - N\overline{x}^2 \tag{2}$$

Jurkevich method folds and groups the observed data according to the test period, then takes the mean value of each batch of grouped data and calculates the sum of squares of deviations V_i^2. The sum of squares of deviations of each group is summed to get the sum of squares of total deviations V_m^2. The mean, the sum of squares of total deviations and the total variance in group 1 are:

$$\overline{\mathrm{x}}_l = \frac{1}{N_l}\sum_{i=1}^{N_l} x_{li} \tag{3}$$

  DOI: 10.25236/isrme.2019.002

$$V_l^2 = \sum_{i=1}^{N_l} x_{li}^2 - N_l \overline{x_l}^2 \quad (4)$$

Where N_l is the number of observed data in group l, the sum of the sum of squares of the respective deviations of *m* groups is:

$$V_m^2 = \sum_{i=1}^{m} V_i^2 \quad (5)$$

When V_m^2 gets the minimum value, it satisfies the test cycle and the real cycle. Then the test period is *P*. By making V_m^2-*P* picture, the test period value corresponding to the minimum value of V_m^2 in the picture is found to determine the period of the data sample. Statistical fluctuations also caused V_m^2 to have a minimum. In 1992, Kidger et al.[6] proposed the F criterion for the periodicity of V_m^2-*P* picture:

$$f = \frac{1 - V_m^2}{V_m^2} \quad (6)$$

In normalized V_m^2-*P* picture, if $V_m^2=1$, that is $f=0$, the sample data does not show periodicity; if $f \geq 0.5$, it shows that the sample data has a strong periodicity; if $f<0.25$, it shows that the sample data may have a weak periodicity.

3. Optical variability photoperiod analysis

The optical R-band of optical variability curves of BL Lac objects PKS 0235-618 from JD2455365 to JD2456728 are shown in Figure 1. The curve consists of 145 observations. The darkest one is at JD2455373 (18.712 magnitude), and the brightest at JD2455974 (15.157 magnitude), with an average brightness of 15.876 magnitude and a standard deviation of 0.686. PKS 0235-618 is very active from the curve of optical variability, and it can be inferred that there may be some periodic components according to the fluctuation of the curve of optical variability. In order to quantify the periodic components of PKS 0235-618, Jurkevich method is used to analyze the data.

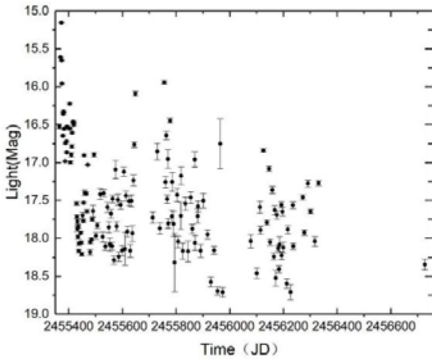

Fig. 1 Optical variability curves of optical R-band of PKS 0235-618

Jurkevich method is used to analyze the periodic components of optical R-band of PKS 0235-618. According to the data in Figure1, different grouping numbers *m* are selected, and the relationship between V_m^2 and *P* is analyzed by taking m=5 and m=9 respectively, which is shown in Figure 2. The abscissa is periodic, the unit is day, and the ordinate is the sum of squares of deviations of different groups. As shown in Figure 2, PKS 0235-618 optical R-band shows strong periodicity. The significant periodic component P = 298 days, and it is not related to the value of *m*, that is, when m=5 and m=9, V_m^2 has a significant trough, *f* values are 0.818 and 0.667 respectively. *f* value is greater than 0.5, which shows that the composition of this cycle is also very significant.

It can be seen from Figure 2, the number of *m* will affect V_m^2-*P* picture. As the number of groups increases, the influence of statistical fluctuations on Jurkevich method becomes larger, V_m^2 signal becomes noisy, so it is important to select the appropriate number of groups. In summary, the optical R-band of BL Lac objects PKS 0235-618 may have periodic components of P=298 days.

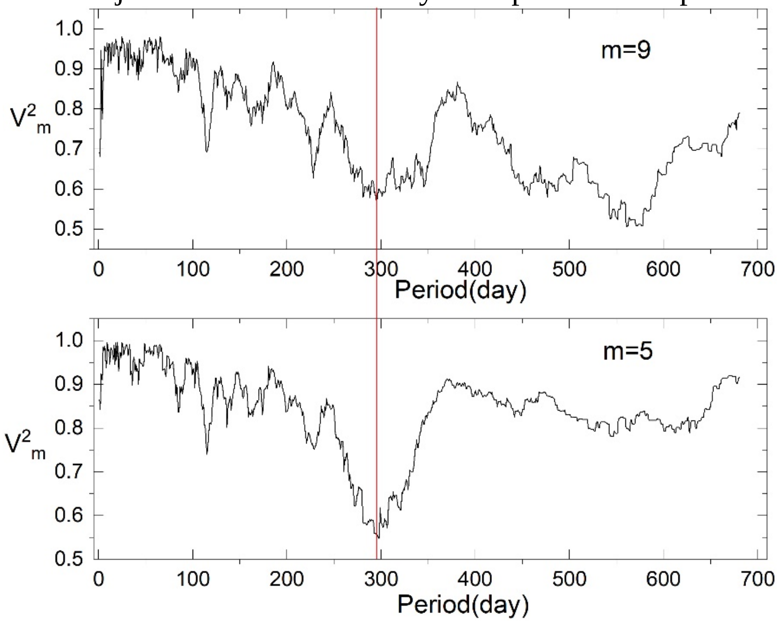

Fig. 2 Relationship of optical R-band V_m^2-P of PKS 0235-618

4. Conclusion and discussion

PKS 0235-618 is a FSRQ objects in optical R-band. SMART carried out a continuous observation of the objects from near infrared to optical wavelengths. Using optical R-band data of PKS 0235-618 observed by SMART from JD2455365 to JD2456728, we processed the data by Jurkevich method, and obtained that there may be 298-day periodic components in optical R-band of PKS 0235-618. The results show that the activity of PKS 0235-618 is intense and optical R-band exhibits certain optical variability law.

Many models have been used to explain the optical variability of AGN, such as the double black hole model[7-8], the spiral jet model[9-12]. As early as 2012, H.E.S.S. proposed that the multi-band radiation of Blazar could be explained by synchronous Compton radiation model[13]. PKS 0235-618 obtained in this paper has a quasi-period of 298 days in optical R-band. It is very likely that the radiation particles produced by the synchronous jet from Compton radiation model change periodically during the propagation process due to the radiation angle, thus causing the periodic change of radiation flow. We can consider that when the radiation angle is small, the radiation flow increases, and the observed results will become brighter; otherwise, when the radiation angle is large, the observed results will be darker because of the smaller radiation flow.

Acknowledgements

This work is supported by the Science Research Project of Education Department of Yunnan Province, China (2018JS506).

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