

# Rapid Polarized Emission Variability of Blazar S5 0716+714 in Optical Range

V. S. Bychkova<sup>a,\*</sup>, N. S. Kardashev<sup>a†</sup>, K. L. Maslennikov<sup>b</sup>, V. L. Plokhotnichenko<sup>c</sup>,  
G. M. Beskin<sup>c, d</sup>, and S. V. Karpov<sup>c, d, e</sup>

<sup>a</sup> *Astro Space Center, Lebedev Physical Institute, Moscow, 117997 Russia*

<sup>b</sup> *Central (Pulkovo) Observatory, Russian Academy of Sciences, St. Petersburg, 196140 Russia*

<sup>c</sup> *Special Astrophysical Observatory, Russian Academy of Sciences, Nizhny Arkhyz, Karachay-Cherkessia, Russia*

<sup>d</sup> *Kazan (Volga region) Federal University, Kazan, 420008 Russia*

<sup>e</sup> *CEICO, Institute of Physics, Czech Academy of Sciences, Praha, Czech Republic*

\**e-mail: bychkova@asc.rssi.ru*

Received September 17, 2019; revised December 20, 2019; accepted December 20, 2019

**Abstract**—The results of polarimetric observations of blazar S5 0716+714, carried out with the 6-meter BTA telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences, are presented. The polarized emission microvariability of blazar S5 0716+714 was observed in the R band with an initial time resolution of 3–5 seconds. Exposures were integrated at 1-minute intervals with a total observation time of several hours over two nights. Microvariability of the polarization degree with amplitude of 3–4% was detected during 7–11 minutes and flux oscillations within 9–10% during 25 minutes. A partial synchronism of the flux oscillations and the polarization degree of this blazar was found. Possible interpretations of the detected microvariability are briefly described.

DOI: 10.1134/S1063772920060013

## 1. INTRODUCTION

Blazars, which include BL Lac objects and flat-spectrum radio quasars, are some of the most active objects in the Universe. Blazars are known for intense radiation and pronounced variability of the total and polarized non-thermal radiation in different wavelength ranges on various time scales, from years to days to hours. Variability in the radio and optical ranges is explained by shocks generated in accretion disks and propagating in relativistic jets.

Currently, the rapid blazar microvariability (from hours to days) in the optical range is firmly established fact [1–3]. However, the polarimetric blazar behavior on short time scales has not been adequately studied. Many studies have confirmed the optical polarization microvariability of some blazars, but so far there is little statistically significant information. Andruchow et al. [4] presented the search results for the polarized radiation microvariability in eighteen objects of the BL Lac type. In some, the polarized emission variability with an amplitude of 2–3% during the time interval of 30 minutes are detected. Variations in the polarization of blazar AO 0235+164 with an amplitude of 2–3% [5] and microvariability in S5 0716+714 with an amplitude of 7% over 1.5 hours [6] were detected. In [7], the

polarized radiation microvariability of blazar S5 0716+714 was detected in the optical and near IR ranges in around 15 minutes with magnitude of  $0.061 \pm 0.005^m$ .

The polarized emission microvariability of blazar S5 0716+714 in the optical range on the time scale from minutes to hours was observed. Object S5 0716+714 is one of the brightest blazars with high variability of the total and polarized emission in different spectral ranges and at different time scales. Blazar ( $z = 0.3$ ) [8, 9] is referred to the class of BL Lac object due to the absence of lines in the spectrum and high radiation variability. It was observed many times in different spectral ranges: the variability of the total and polarized flux in the radio and optical ranges, as well as the total radiation flux in the gamma-ray range, was detected. Bhatta et al. [10] obtained the value of the polarized blazar flux S5 0716+714 in the R filter with an amplitude of  $(40\text{--}60)\% \pm (2\text{--}10)\%$  during one hour. Larionov et al. [11] observed a blazar flare from 2005 to 2011 in the total and polarized flux in the optical range. The results showed intense variability on both long (months–years) and short (days–weeks) time scales. Impey et al. [12] conducted polarimetric observations of blazar S5 0716+714 from 1991 to 1994 and detected oscillations in the polarization degree over a time interval of 10–15 minutes. However, at

† Deceased.