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LONG-TERM OPTICAL PHOTOPOLARIMETRIC MONITORING OF BLAZARS AT SAN PEDRO MÁRTIR

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RESUMEN

La variabilidad de luz polarizada en el óptico ha resultado ser una herramienta poderosa para estudiar a los Blázares debido a que permite determinar la intensidad y orientación del campo magnético asociado al jet relativista. También la luz polarizada es útil para estimar el sitio donde se origina la emisión de rayos-gama, aun cuando el mecanismo físico responsable de su producción sigue sin aclararse. Más importante aún, dado que las campañas en multifrecuencias típicamente se concentran en fuentes que están en estados de alta actividad, las características de las propiedades polarimétricas de Blázares en las fases pre- y post-estallido son menos conocidas. Por tanto, hemos iniciado un programa de monitoreo dedicado de Blázares de la muestra GASP en San Pedro Mártir para estudiar sus propiedades de variabilidad. En este trabajo queremos mostrar el estado en el que se encuentra el programa presentando algunos resultados preliminares sobre la variabilidad polarimétrica en el óptico y de rayos γ observada con Fermi-LAT en el blázar PKS 1510−089.

ABSTRACT

Variability of optical polarized light has result to be a powerful tool for studying Blazars, since it enable us to determine the strength and orientation of magnetic field associated with the relativistic jet. Also, polarized light is a valuable way of testing the location of the γ-ray emission, although the physical mechanisms responsible of its production remain unclear. Most importantly, since multi-wavelength campaigns typically concentrate on sources during highly active states, the characteristic polarimetric properties of Blazars in the pre-and post outbursts states are less known. Thus, we have started a dedicated monitoring program of Blazars from the GASP sample at San Pedro Mártir, in order to study their polarimetric variability properties. In this work we want to show the current status of the program presenting some preliminary results on the optical-polarimetric and γ-ray variability observed with Fermi-LAT on the blazar PKS 1510−089.

Key Words: galaxies: active — BL Lacertae objects: general

1. INTRODUCTION

Blazars are the extreme sub-population of the entire AGN class and include the BL Lac objects, and the flat spectrum radio quasars (FSRQ). Their overall spectral energy distribution (SED) shows two distinct emission peaks. Usually, the first peak is fitted assuming that the continuum emission is produced by synchrotron radiation, e.g., Marscher (1998). The second peak in the SED is usually observed in the high-frequency region (X-rays to γ-rays). The origin of the seed photons that are scattered in the second peak is still not completely well established. They may be synchrotron photons produced in the relativistic jet (SSC process) or can come from regions outside the jet (EC-models) like the accretion disk, the broad-line region or the dusty torus, e.g., Böttcher & Dermer (2010). Also, there are other models that assume that the γ-rays can be produced from particle cascades (Mannheim 1993; Blandford & Levinson 1995).

It has been recently shown that the study of the correlation between γ-ray activity and the variability of the optical polarization in blazars provides new information on the jet structure and the location and origin of the high-energy emission, see Agudo et al. (2011). Therefore, we are currently undertaken an optical-polarimetric monitoring program of 32 gamma-ray blazars (see Sorcia et al. 2011) that started in January 2008. In this paper, we will show our results on the object PKS 1510−089

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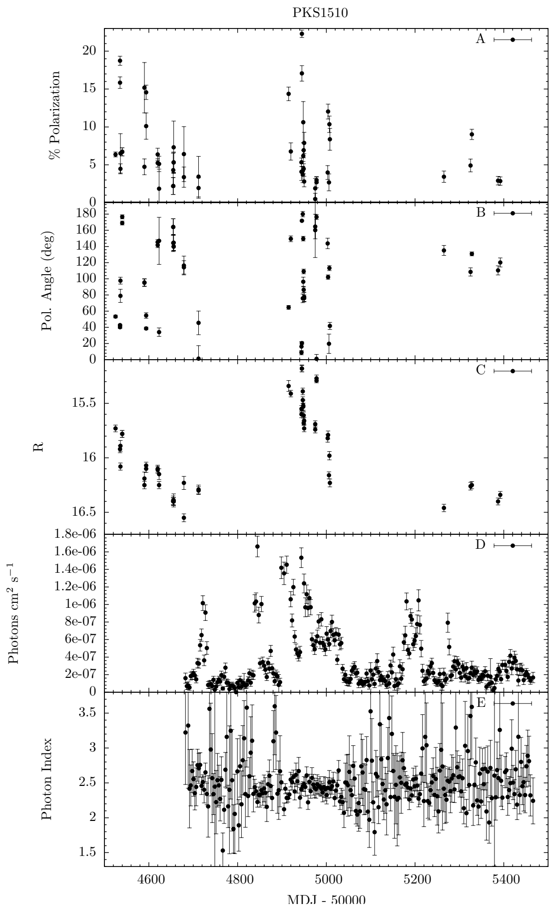

Fig. 1. Panel (A) shows the polarization percentage P(%), (B) the rotation of the optical polarization angle (PA), (C) the R-band variations obtained within our Polarimetric Monitoring project. Panels (D) and (E) shows γ-ray light-curves for the monitored period obtained with LAT.

from 2008 to 2010 and look for possible correlations with data obtained with the Large Area Telescope (LAT) onboard Fermi, obtained from August 2008 to September 2010. Some of our R-band photometric data on this source have been already published in D'Ammando et al. (2009, 2011) as part of the GASP-WEBT monitoring project (Villata 2010). However, our polarization data obtained from 2008–2010 are shown here for the first time.

2. RESULTS FOR PKS 1510−089

Our particular goal is to show some of the flares displayed by the blazar PKS 1510−089 in the optical and also in the γ-ray domain and see if we can find some connection between polarization variability and high-energy activity. PKS 1510−089 is a nearby ($z = 0.361$) FSRQ with the inverse Compton component dominated by the γ-ray emission, and the synchrotron emission peaked around IR frequencies. The relativistic jet of this blazar presents an angle of 2.58° with respect to the observer accordingly with D'Ammando et al. (2009).

In Figure 1 we show the Light Curves obtained in the optical and also the corresponding behavior observed with LAT. γ-ray data (0.1–200 GeV) were processed using the standard software (Atwood et al. 2009) and has been modeled using a power law for the photon flux. The γ-Light Curve shown has been binned in periods of 3 days. The large errors in the spectral index are due to a low count rate. From our optical data, we have estimated the variability timescale and found $\tau = 2.58$ days. From the figure it is clear that the source was in a flaring state in March 2009. This flare was also observed in the γ-rays with AGILE (D'Ammando et al. 2011) and with LAT. We can also observe a second γ-ray flare around December 15th 2009 and a second peak around January 12th 2010. Unfortunately, we did not get data on that time due to technical problems. On the other hand, there is also a pre-flare state around 54720 MJD (September 2008) observed with LAT that is partially covered by our optical data.

3. DISCUSSION

As preliminary results we should say that we have observed a 100% duty-cycle in total and polarized light and not preferred PA for this blazar. Also, Figure 1 shows that the source was on a very high activity state in the optical and in the γ-ray region around MJD 54945. This date corresponds to March 24 2009. We have the maximum polarized value for this date (22.30 ± 0.49%), and the maximum brightness of the source ($R = 15.18 \pm 0.03$). In this object there seems to be a correlation between the polarization degree and the flux in both bands.

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