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Multiwavelength variability analysis of the FSRQ 3C 279

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Abstract. We present a multifrequency analysis of the variability in the flat-spectrum radio quasar 3C 279 from 2008 to 2014. Our multiwavelength dataset includes gamma-ray data from Fermi/LAT (Abdo *et al.* 2009), observations in 1mm from SMA (Gurwell *et al.* 2007), Near Infrared from OAGH (Carramiñana & Carrasco 2009) and SMARTS (Bonning *et al.* 2012); optical V band from the Steward Observatory (Smith *et al.* 2009) and SMARTS; optical spectra from OAGH (Patiño-Álvarez *et al.* 2013) and the Steward Observatory; and polarization spectra from the Steward Observatory. The light curves are shown in Fig. 1. Six out of seven optical activity periods identified within our dataset show clear counterparts in mm, NIR and gamma-rays, however, the late 2011 - early 2012 optical flare does not have a counterpart in the GeV regime. In this contribution, we discuss the flaring evolution of 3C 279 and speculate about the production of the anomalous activity period.

Keywords. galaxies: active, galaxies: jets, gamma rays: galaxies, quasars: individual (3C 279)

1. Introduction

3C 279, a source at z = 0.536 was one of the first gamma-ray quasars discovered with the Compton Gamma-Ray Observatory (Hartman *et al.* 1992). It has long been known that the emission of this source is highly variable, from the radio, optical, up to γ-rays. Therefore, several intensive multi-wavelength campaigns (see, e.g., Abdo *et al.* 2010, Bonning *et al.* 2012) and theoretical studies (e.g., Böttcher & Principe 2009) have led to some important conclusions about the physical properties of 3C 279. Despite those studies, a general consensus about the location of the gamma-ray production zone in 3C 279 does not yet exist.

2. Correlation analysis

Using cross-correlation analysis we have found zero delay among the UV λ3000 Å continuum emission, the optical V band, and the NIR J, H and K bands. This correlation allows us to speculate that the emission from the middle UV range to the NIR is emitted in the same region. Based on this, every correlation we find with the λ3000 Å continuum emission is assumed to exist also with the V and NIR bands. We report the finding of a significant correlation ($\rho = 0.65$, P $<<$ 0.01) between the λ3000 Å continuum emission and 1mm emission during our entire observation time range. This strongly suggests that the UV continuum emission is dominated by non-thermal emission from the jet. These results strongly suggest that the continuum emission from the UV to the NIR bands, during the observation period, share the same non-thermal origin. The highly variable

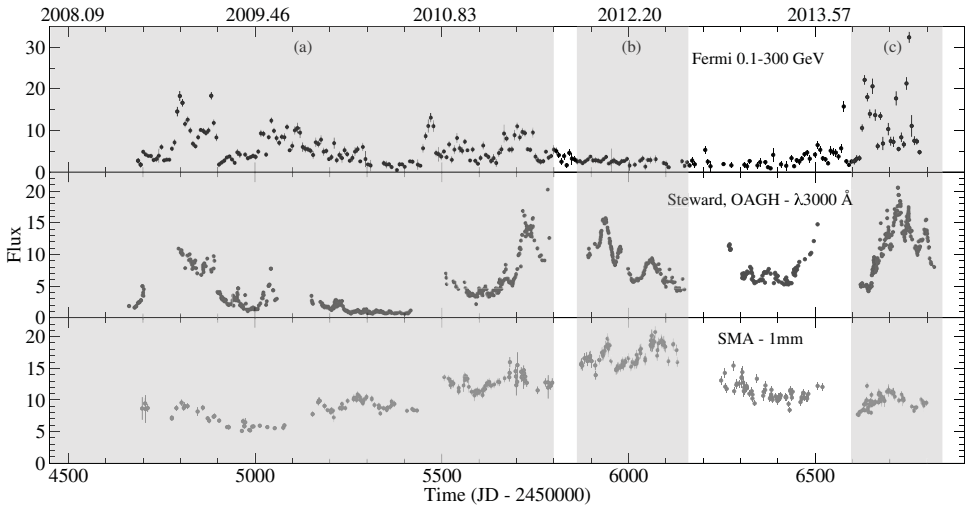

Figure 1. Multiwavelength light curves for 3C 279. Figure units are: Top panel [ph cm^{-2} s^{-1}]; middle panel [$\times 10^{-15}$ erg cm^{-2} s^{-1} Å^{-1}]; bottom panel [Jy].

levels of optical degree of polarization shown during the different flares further strengthen the idea of the optical continuum (and therefore UV and NIR) having a non-thermal origin. The cross-correlation analysis shows a delay of -8.7 ± 13.4 days between the λ3000 Å continuum emission and the gamma-rays during period "a". However, during period "c" (see Figure 1) we find a delay of -72.6 ± 8.8 days among the same bands.

3. Anomalous activity period

We report the finding of an anomalous activity period in the light curves of 3C 279. In this period we find two flares in the λ3000 Å continuum with counterparts in the optical V and NIR bands, as well as the highest flux levels of 1mm emission during our entire time range. However, there is no counterpart in the gamma-rays to any of these two flares (see period "b" in Figure 1). A similar behavior has been previously reported for the source PKS 0208-512 (Chatterjee *et al.* 2013) where they speculate this was caused by a change in the magnetic field without any change in the total number of emitting electrons or Doppler factor of the emitting region.

The reason behind the different delays that we find in our light curves (period "a" and "c"), and the lack of a counterpart in gamma-rays in period "b" is unclear; however we are still investigating the nature of this peculiar flaring behavior.

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