

Long-term multi-wavelength variability and correlation study of Markarian 421 from 2007 to 2009

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Abstract

© ESO 2016. Aims. We study the multi-band variability and correlations of the TeV blazar Mrk 421 on year timescales, which can bring additional insight on the processes responsible for its broadband emission. Methods. We observed Mrk 421 in the very high energy (VHE) -ray range with the Cherenkov telescope MAGIC-I from March 2007 to June 2009 for a total of 96 h of effective time after quality cuts. The VHE flux variability is quantified using several methods, including the Bayesian Block algorithm, which is applied to data from Cherenkov telescopes here for the first time. The 2.3 yr long MAGIC light curve is complemented with data from the Swift/BAT and RXTE/ASM satellites and the KVA, GASP-WEBT, OVRO, and Metshovi telescopes from February 2007 to July 2009, allowing for an excellent characterisation of the multi-band variability and correlations over year timescales. Results. Mrk 421 was found in different -ray emission states during the 2.3 yr long observation period: The flux above 400 GeV spans from the minimum nightly value of $(1:30:4) \times 10^{11} \text{ cm}^2 \text{ s}^{-1}$ to the maximum flux, that is about 24 times higher, at $(3:10:1) \times 10^{10} \text{ cm}^2 \text{ s}^{-1}$. Flares and different levels of variability in the -ray light curve could be identified with the Bayesian Block algorithm. The same behaviour of a quiet and active emission was found in the X-ray light curves measured by Swift/BAT and the RXTE/ASM, with a direct correlation in time. The behaviour of the optical light curve of GASP-WEBT and the radio light curves by OVRO and Metshovi are different as they show no coincident features with the higher energetic light curves and a less variable emission. Overall, the fractional variability increases with energy. The comparable variability in the X-ray and VHE bands and their direct correlation during both high- and low-activity periods spanning many months show that the electron populations radiating the X-ray and -ray photons are either the same, as expected in the synchrotron-self-Compton mechanism, or at least strongly correlated, as expected in electromagnetic cascades.

Keywords

Astroparticle physics, BL Lacertae objects: individual: Markarian 421, Radiation mechanisms: non-thermal