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Study of persistent VHE gamma-ray emission detected with the MAGIC telescopes from PKS 1510-089, during low flux states detected by Fermi-LAT

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PKS 1510-089 is one of the few Flat Spectrum Radio Quasars (FSRQs) detected in the very-high-energy (VHE, E>100 GeV) gamma-ray band. FSRQs can only be detected in the VHE band typically during flaring state. It is due to their low energy peaking spectral energy distributions (SEDs) w.r.t. BL Lac objects, and their steep gamma-ray spectra (which could even include some intrinsic absorption). During flaring states, typically not only the fluxes are enhanced but also their SED peaks are shifted towards higher energies, facilitating the detection in the VHE band with Cherenkov telescopes. The FSRQ VHE family is only limited to seven sources (TeVCat [1]), and their discovery in the VHE band challenges the theoretical emission scenarios. Up to now, such studies were biased towards flaring states. In this work, we present the first study of a FSRQ showing persistent emission outside of the flaring states.

The MAGIC telescopes have monitored this source regularly since 2012. In order to select the periods when the source was not highly active, the *Fermi*-LAT gamma-ray survey data above 1 GeV have been used. A flux threshold of $3 \times 10^{-8}\,\mathrm{ph\,cm^{-2}\,s^{-1}}$ at energies above 1 GeV was set as definition of the low gamma-ray activity state. Based on such selection criteria, 75 h of VHE data from the MAGIC telescopes was selected for this analysis taken from 2012 to 2017. The VHE low-state data sample yields a significant detection at the level of $9.5\,\sigma$. The measured flux is smaller by a factor of 80 times w.r.t. the highest flux observed from this object, $(4.3 \pm 0.6) \times 10^{-12}\,\mathrm{ph\,cm^{-2}\,s^{-1}}$ above 150 GeV. The spectral shape however, even during low state, is consistent with the one observed from PKS 1510-089 during flaring states.

The MWL SED during the low gamma-ray state is built from radio to the VHE band and modeled within the External Compton framework. No absorption features are detected in the GeV-VHE gamma-ray regime, constraining the location of the emitting region beyond the broad line region (BLR) to allow the VHE photons to escape unattenuated. Therefore, the target photons for the inverse Compton scattering correspond to the IR photons from the torus. This is the first time that constraints on the location of the emitting region within the relativistic jets of FSRQs during no flaring states can be derived. Such constraint is compatible with the previous findings from the VHE FSRQ family detected during high states. All the details on the analysis and results can be found in MAGIC Collaboration et al. 2018 [2].

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References

[1] http://tevcat.uchicago.edu

[2] MAGIC Collaboration et al. 2018, A&A, 619, A159