

Studying the long-term spectral and temporal evolution of 1ES 1959+650

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The high-frequency peaked BL Lac type object (HBL) 1ES 1959+650 is one of the brightest blazars in the very-high-energy (VHE, $E > 100$ GeV) gamma-ray sky. HBLs have been proposed as possible neutrino emitters implying the presence of hadrons in the emission mechanisms. In 2002, AMANDA reported neutrino candidates from this source simultaneously observed with a gamma-ray flaring activity without an X-ray emission enhancement, interpreted as an orphan flare. Standard one-zone synchrotron self-Compton emission models cannot explain this behavior.

The MAGIC telescopes have been observing 1ES 1959+650 since 2004. An extreme outburst triggered by multi-wavelength observations reaching 300% of the Crab nebula flux level above 300 GeV was detected in 2016. Leptonic and hadronic models are equally successful in describing the observed emission. To study the long-term behavior and the characteristics in different emission states of 1ES 1959+650, we have monitored it densely since 2017 for more than 300 hours. Together with the FACT monitoring (more than 2000 hours since 2012), this is the most intense monitoring for any blazar after Mrk 421 and Mrk 501 in the VHE range. The monitoring showed a decline of the VHE flux with occasional flaring episodes reaching in 2019 a low-state emission corresponding to 10% of the Crab nebula.

We will present the long-term monitoring study results using multi-wavelength data from MAGIC, FACT, Fermi-LAT, and Swift. Furthermore, we will discuss the differences in the spectral energy distributions between the flaring states from 2016 and the low state in 2019.

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