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Multi-messenger characterization of Mrk501 during historically low X-ray and γ-ray activity

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Blazars are among the most prominent and luminous objects in the γ-ray sky, but the mechanisms and particle populations behind their emission are still far from understood. The two MAGIC telescopes contribute to solving these riddles by regularly monitoring our closest blazars in the very-high-energy (>0.2 TeV, VHE) regime, which is particularly effective when accompanied with observations from other multiwavelength (MWL) instruments.

In this contribution we present the insights gained from our MWL data set of Mrk 501 collected between 2017 to 2020 with additional results gained when extending the data to the time period from 2008 to 2020. For the first time, we can identify significant correlations between the VHE γ-rays and X-rays for Mrk 501 also during very low-activity states as shown in our 4-year data set. Additionally, the measured correlations in both data sets reveal a delay of the radio emission with respect to the HE γ-rays by more than 100 days suggesting that the HE γ-ray emission is located further upstream the radio-bright regions in the jet of Mrk 501. Moreover, from the mid of 2017 to the mid of 2019 a historically low-state in both VHE as well as X-rays can be detected. The emission is stable with a VHE flux of 5% that of the Crab Nebula, as detected by MAGIC. We investigated the nature of this potential baseline emission using our MWL information together with published multi-messenger results from IceCube setting constraints on possible leptonic, lepto-hadronic and purely hadronic emission scenarios. While the stable emission could originate from a standing shock, the more variable emission in the months before the low-state can be attributed to an independent shock region traveling along the jet of Mrk 501.

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