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Unveiling the complex correlation patterns and emission mechanisms in Mrk 421

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Thanks to its brightness and proximity, the BL Lac type object Mrk 421 is an ideal target to probe blazar jet physics. We present a detailed characterisation and theoretical interpretation of the broadband emission of Mrk 421, focusing on the multi-band flux correlations. The analysis makes use of an extensive multi-wavelength campaign organised in 2017, during which the correlation patterns show some disparity and complex behaviours. Four multi-hour NuSTAR observations were organised simultaneously to those from MAGIC, which allow us to obtain a precise measurement of the high energy turnover of the two spectral bumps. A detailed investigation of the very-high-energy (VHE; >100 GeV) versus X-ray flux correlation is performed, by binning the data into several sub-energy bands. A positively correlated variability is observed at a significance level above 5 sigma, but the correlation changes substantially across the various bands probed. Furthermore, during the simultaneous MAGIC and NuSTAR observations, a variation of the inverse Compton component up to a factor 3 is detected, without a corresponding variability in the synchrotron regime, what is usually referred to as an "orphan gamma-ray activity". During the campaign, we also detected an intriguing bright flare at VHE without a substantial flux increase in the X-rays. Within a leptonic scenario, this behaviour is best explained by the appearance of a second population of highly-energetic electrons spanning a narrow range of energies. Finally, our intra-band correlation study reveals an anti-correlation between the UV/optical and X-ray bands at a significance level above 3 sigma. This behaviour suggests changes in the acceleration and cooling efficiencies of the electrons.

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Summary

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