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First broadband characterization of the TeV blazars Mrk 421 and Mrk 501 with simultaneous X-ray polarization measurements

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Blazars are among the most luminous objects in the γ-ray sky, but the mechanisms behind their emission are still far from understood. In 2022, IXPE reported the first detection of X-ray polarization of blazars, opening a new window for testing acceleration and radiation models.
In this contribution, we present the insights gained on the two archetypal TeV blazars Mrk 421 and Mrk 501 exploring their multi-wavelength behavior during the first IXPE observations. We investigate the X-ray polarization evolution, and combine it, for the first time, with multi-wavelength data from the radio up to the very-high-energy (>0.2 TeV) regime.
For Mrk 501, we find a clear evidence for an extreme emission state in March 2022 with a synchrotron component peaking above 1 keV. In July 2022, it shifts back to lower energies accompanied by a drop in polarization degree in the X-rays. We explain these observations using a two-zone model which builds on the assumption of an energy-stratified jet as indicated by the IXPE results. The shift of the synchrotron peak can be directly connected with the change in polarization degree by a change of magnetization and/or emission region size.
Mrk 421 shows a variety of emission states during the IXPE campaigns, enabling us to correlate polarization signatures with other multi-wavelength features. In June 2022, a polarization angle swing is observed by IXPE which we connect with a X-ray flux increase and a clear spectral hardening. Simultaneously, our NuSTAR analysis reveals two spectral hysteresis loops going in opposite directions. We use these unique signatures to constrain acceleration and cooling processes.

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