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Multifrequency polarimetry of High-Synchrotron Peaked blazars probes the shape of their jets

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Multifrequency polarimetry is emerging as a powerful probe of blazar jets, especially due to the advent of the Imaging X-ray Polarimetry Explorer (IXPE) space observatory.
We study the polarization of High-Synchrotron Peaked (HSP) blazars, where both optical and X-ray emission can be attributed to synchrotron radiation from a population of non-thermal electrons. We adopt an axisymmetric stationary force-free jet model, where the electromagnetic fields are determined by the jet shape. In particular, the jet geometry is defined by the pressure profile of the external medium confining the jet. When jets are confined by a windy-like medium, they acquire a quasi-parabolic shape. In this case, the X-ray polarization degree is Pi_X ~ 15–40%, and the optical polarization degree is Pi_O ~ 5–20%. The polarization degree is strongly chromatic, as Pi_X/Pi_O ~ 2–5. The chromaticity is due to the softening of the electron distribution at high energies, and is much stronger than for a uniform magnetic field.
The Electric Vector Position Angle (EVPA) is aligned with the projection of the jet axis on the plane of the sky. These results compare very well with multifrequency polarimetric observations of HSP blazars. Instead, when the jet is nearly cylindrical, the polarization degree is large and weakly chromatic (we find Pi_X ~ 70% and Pi_O ~ 60%), close to the expected values for a uniform magnetic field.
The EVPA is perpendicular to the projection of the jet axis on the plane of the sky. We also provide analytical approximated formulae, valid for small viewing angles, for both the polarization degree and the EVPA as a function of the spectral-index.
The polarization degree is highly chromatic unlike the EVPA. The polarization degree and the EVPA may be less sensitive to the specific particle acceleration process (e.g., magnetic reconnection or shocks) than previously thought.

Primary author: Mr BOLIS, Filippo (DiSAT, Università dell'Insubria and INAF – Osservatorio Astronomico di Brera)

Co-authors: Dr SOBACCHI, Emanuele (Gran Sasso Science Institute and INAF – Osservatorio Astronomico di Brera); Dr TAVECCHIO, Fabrizio (INAF – Osservatorio Astronomico di Brera)

Presenter: Mr BOLIS, Filippo (DiSAT, Università dell'Insubria and INAF – Osservatorio Astronomico di Brera)

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