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Decoding Blazar Polarization

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The intricate polarization patterns seen in blazar jets, particularly highlighted by findings from the Imaging X-ray Polarimetry Explorer (IXPE), require multizone model frameworks to describe polarization behavior in blazar jets accurately. Single-zone models, which assume a uniform magnetic field and particle distribution, cannot explain the significant polarization degree and angle variability across different energy bands, as observed in blazars like Mrk 421 and Mrk 501. These results emphasize the need for multizone models, which consider non-uniform magnetic fields and energy distribution to elucidate the observed polarization.

This presentation will delve into the multizone model's capacity to elucidate the intricate polarization characteristics of blazars, with a particular focus on the Double Depolarization effect. This phenomenon occurs when synchrotron seed photons, scattered across multiple jet regions with varying magnetic field orientations, undergo a two-step depolarization process, significantly lowering the observed polarization degrees.

Finally, we will demonstrate how the model predictions for high-energy polarimetry in blazars, incorporating multizone effects, as well as models for other spectral features like the Big Blue Bump in blazar spectral energy distributions (SEDs), can improve our understanding of blazar jets. These predictions provide deeper insights into jet composition, particle acceleration, and magnetic field structures, offering a complete framework for interpreting current and future polarimetric observations.

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