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Inverse Compton scattering from Bethe-Heitler pairs as a plausible origin of hard spectra in distant TeV blazars: 1ES 0414+009 and 1ES 1959+650

Blazars are a special subclass of active galactic nuclei (AGNs) characterized by a relativistic jet aligned at a small angle to the observer's line of sight. Their spectral energy distributions (SEDs) are dominated by non-thermal emission and exhibit two broad, distinct components: a low-energy component, spanning from radio to UV or X-ray wavelengths, and a high-energy component, extending from X-ray to gamma-ray energies. It is widely believed that the low-energy emission in blazar SEDs originates from synchrotron radiation produced by relativistic electrons within the jet. However, the origin of the high-energy component remains a subject of debate. Two primary theoretical models attempt to explain this emission: i) leptonic model: High-energy photons are generated via inverse Compton scattering, where relativistic electrons interact with a surrounding photon field. Potential soft photon sources include synchrotron photons produced within the jet itself, known as synchrotron self-Compton (SSC) emission; and ii) Hadronic Model: High-energy emission arises from proton synchrotron radiation or from secondary emission produced by proton-proton (pp) and proton-photon (p γ) interactions. In this work, we model the SEDs of high-frequency-peaked BL Lac objects (HBLs): 1ES 0414+009 and 1ES 1959+650. The hard gamma-ray spectra of these sources suggest the possible contribution of an additional spectral component beyond the standard SSC emission, indicating a more complex emission mechanism at play. We suggest that the hard gamma-ray spectrum for the blazars may originate from inverse Compton scattering from Bethe-Heitler pairs along the line of sight.

Collaboration(s)

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