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Estimating the Potential of the Cherenkov Telescope Array Observatory to Measure the Luminosity Function of Very-High-Energy Blazars

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The Cherenkov Telescope Array Observatory (CTAO) is the next-generation ground-based observatory for gamma-ray astronomy, covering a very broad energy range from 20 GeV to beyond 100 TeV. The luminosity function (LF) of very-high-energy (VHE) blazars measures their evolution over cosmic time, constrains their contribution to unresolved radiation fields, and connects them to source populations measured in different wavebands and with other messengers. In particular, Fermi-LAT has measured the LF of blazars in the high-energy range. In this work, we probe the potential of CTAO to reconstruct a VHE blazar LF in the context of the CTAO extragalactic survey, a key science project which will include an unbiased observation of 25% of the sky. To simulate populations of VHE blazars, we generate VHE blazar populations by randomly sampling fluxes from BL Lac LFs, assigning each source a power-law spectral shape, and extrapolating to higher energies while accounting for absorption by the extragalactic background light. To assess CTAO's capability to reconstruct these simulated LFs through Markov Chain Monte Carlo sampling, the study incorporates both its Northern and Southern arrays, accounting for telescope effects based on the instrument response functions of the alpha configuration. This configuration refers to the first construction phase with an array of 4 Large-Sized Telescopes (LSTs) and 9 Medium-Sized Telescopes (MSTs) in the northern site (CTAO-North), and 14 MSTs and 37 Small-Sized Telescopes (SSTs) in the southern site (CTAO-South). These results will provide key information into the feasibility of measuring the VHE blazar LF with CTAO, helping to refine expectations for its extragalactic survey and its contribution to our understanding of blazar populations.

Collaboration(s)

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