Contribution ID: **72** Type: **Poster + Flashtalk**

Probing the Parameter Space of Axion-Like Particles Using Simulation-Based Inference

Axion-like particles (ALPs) appear in various extensions of the Standard Model and can interact with photons, leading to ALP-photon conversions in external magnetic fields. This phenomenon can introduce characteristic energy-dependent "wiggles"in gamma-ray spectra. The Cherenkov Telescope Array Observatory (CTAO) is the next-generation ground-based gamma-ray observatory, designed to enhance sensitivity and energy coverage (20 GeV –300 TeV) over current Imaging Atmospheric Cherenkov Telescopes (IACTs) and offers an excellent opportunity to study such effects.

In this work, we employ Simulation-Based Inference (SBI) to explore the parameter space of ALPs. Additionally, we investigate whether this inference method can produce accurate ALP exclusion limits comparable to those reported in previous studies that use the classical likelihood-ratio approach. Through this approach, we seek to yield robust constraints on ALP-photon interactions and make substantial advancements in this field.

AI keywords

Simulation Based Inference, Neural Ratio Estimation, Bayesian Neural Networks, Posterior Estimation

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Track Classification: Inference & Uncertainty