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AI in the Cosmos: Application of neural networks for modeling multiwavelength and multimessenger data from blazar observations

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The integration of Artificial Intelligence (AI) into astronomy and astrophysics marks a transformative era in the exploration of the Universe, enhancing the analysis of vast data sets with unparalleled efficiency and precision. AI is revolutionizing the usability of observational data, expanding our understanding of various cosmic phenomena. Blazar research particularly benefits from the application of AI. In this talk, I will present a pioneering effort in employing a Convolutional Neural Network (CNN) for the efficient modeling of blazar emissions. Blazars are among the most powerful extragalactic sources, emitting across the entire electromagnetic spectrum, from radio to very high-energy gamma-ray bands. As significant sources of non-thermal radiation, blazars are frequently monitored by various telescopes, leading to the accumulation of substantial multi-wavelength data over different time periods. Also, over the years, the complexity of models of blazar emission has dramatically increased which hinders parameter exploration and makes data interpretation through model fitting challenging. By training the CNN on lepton-hadronic emission models generated for a set of models computed with the kinetic code SOPRANO, which considers the interaction of initial and all secondary particles, the resultant CNN can accurately model the radiative signatures of electron/proton interactions in relativistic jets. This CNN-based approach significantly reduces computational time, thereby enabling fitting to multi-wavelength (photons) and multi-messenger (neutrinos) datasets. The adoption of this AI-driven methodology enables self-consistent modeling of blazar emissions, offering profound insights into their underlying physics and potentially uncovering new astrophysical phenomena. I will present and discuss several results where these networks have been used to model multi-wavelength, multi-temporal data from blazar observations.

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