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Modeling of Blazar Multimessenger Emission with Convolutional Neural Network

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Multimessenger observations, combining electromagnetic radiation and neutrinos, offer critical insights into the high-energy processes occurring in astrophysical sources. Recent coincident detections of high-energy neutrinos from the direction of blazars highlight them as ideal candidates for multimessenger modeling, and at the same time underscore the necessity of accurate modeling frameworks to interpret these complex signals. However, conventional hadronic models that explain neutrino emission from blazars are computationally intensive, complicating thorough parameter-space exploration and precise data fitting. In this presentation, I introduce a novel approach based on convolutional neural networks (CNNs), specifically designed to significantly accelerate the modeling of multimessenger blazar emissions. This CNN, trained on outputs from the SOPRANO numerical code, effectively and accurately reproduces the radiative signatures of protons, electrons, and secondary particles, transforming computationally demanding hadronic emission calculations into an efficient tool for rapid exploration and robust statistical fitting of observational data. I demonstrate the application and efficacy of this CNN-based method through fitting multimessenger observational data from blazars TXS 0506+056 and PKS 0735+178, showing the capability of the model to effectively constrain physical parameters and interpret multimessenger emission from blazar jets. This innovative methodology advances our understanding of blazar physics and provides a powerful analytical framework for future multimessenger astrophysics studies.

Collaboration(s)

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