Contribution ID: **52** Type: **Talk without Poster**

Modeling blazar broadband emission with convolutional neural network

Tuesday, 30 April 2024 17:22 (20 minutes)

Blazars are among the most powerful extragalactic sources, emitting across the entire electromagnetic spectrum, from radio to very high energy gamma-ray bands. As powerful sources of non-thermal radiation, blazars are frequently monitored using various telescopes, leading to the accumulation of substantial multi-wavelength data over different time periods. Also, over the years, the complexity of models has dramatically increased. This complexity hinders parameter exploration and makes data interpretation through model fitting challenging. I will present the pioneering effort in employing a Convolutional Neural Network (CNN) for the efficient modeling of blazar emission. By training the CNN on lepton-hadronic emission models generated from a set of models computed with the kinetic code SOPRANO, where the interaction of initial and all secondary particles is considered, the resultant CNN can accurately model the radiative signatures of electron/proton interactions in relativistic jets with high accuracy. This CNN-based approach significantly reduces computational time, thereby enabling real-time fitting to multi-wavelength (photons) and multi-messenger (neutrinos) datasets. This approach allows self-consistent modeling of blazar emission, which holds the potential for deepening our understanding of their physics. I will also present the novel Markarian Multiwavelength Datacenter (www.mmdc.am), where all the models are publicly available, allowing everyone to perform state-of-the-art, self-consistent analyses of multi-wavelength and multi-messenger data from blazar observations.

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Session Classification: 3.2 Physics-informed AI & Integration of physics and ML