EUROPEAN AI FOR FUNDAMENTAL PHYSICS CONFERENCE
EuCAIFCon 2025

Contribution ID: **40** Type: **Poster + Flashtalk**

Emulating CO Line Radiative Transfer with Deep Learning

The adoption of AI-based techniques in theoretical research is often slower than in other fields due to the perception that AI-based methods lack rigorous validation against theoretical counterparts. In this talk, we introduce COEmuNet, a surrogate model designed to emulate carbon monoxide (CO) line radiation transport in stellar atmospheres.

COEmuNet is based on a three-dimensional residual neural network and is specifically trained to generate synthetic observations of evolved star atmospheres. The model is trained on data from hydrodynamic simulations of Asymptotic Giant Branch (AGB) stars perturbed by a binary companion. Given a set of input parameters, including velocity fields, temperature distributions, and CO molecular number densities, the COEmuNet model emulates spectral line observations with a mean relative error of ~7% compared to a classical numerical solver of the radiative transfer equation, while being 1,000 times faster.

This presentation will also include some of our preliminary results, demonstrating the improved performance achieved through Physics-Informed Machine Learning (PIML) applied to the same problem, highlighting its potential for accelerating radiative transfer modelling in AGB stars.

AI keywords

surrogate models, physics informed machine learning, convolutional neural networks

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Track Classification: Explainability & Theory