Contribution ID: **507** Type: **Talk in a parallel session**

Gamma-proton identification based on multi-model ensemble algorithm

Friday, 12 July 2024 16:00 (20 minutes)

Identifying gamma-rays and rejecting the background of cosmic ray hadrons are crucial for very-high-energy gamma-ray observation and relevant scientific research. Based on the simulated data from the square kilometer array (KM2A) of LHAASO, eight high-level features are extracted for the gamma/hadron classification. Machine-learning (ML) models, including logistic regression, support vector machines, decision trees, random forests, XGBoost, CatBoost and deep neural networks (DNN), are constructed and trained using datasets of four energy bands ranging from 10^{12}eV to 10^{16}eV, and finally fused using the stacking integration algorithm. To comprehensively assess the classification ability of each model, the accuracy, F1 score, precision, recall and AUC value of the ROC curve are used. The results show that the ML methods have a significant improvement on particle classification in LHAASO-KM2A, particularly in the low-energy range. Among these methods, XGBoost, CatBoost and DNN achive a higher classification accuracy than decision trees and random forests, while the fusion model exhibits the highest accuracy. The ML methods provide a useful and alternative method for gamma/hadron identification.

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Session Classification: Machine learning in astronomy: AGN, transient events, cosmology and others

Track Classification: Artificial Intelligence Methods (AI): Machine learning in astronomy: AGN, transient events, cosmology and others