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Cosmic Ray Simulations for CONDOR Observatory and Angular Reconstruction via Machine Learning

The COmpact Network of Detectors with Orbital Range (CONDOR) Observatory is an upcoming cosmic ray detection facility set to be constructed at an altitude of ˜5000 meters a.s.l. in the Atacama Desert, making it the highest cosmic rays detector in the world, designed to observe gamma and cosmic rays at the low-energy range (˜GeV-Tev). By focusing on this relatively unexplored range, CONDOR is poised to make significant contributions to astroparticle physics. In this study, we present advances in the reconstruction of cosmic ray arrival angles using detailed simulations performed with CORSIKA. Data preprocessing techniques were employed to extract meaningful features from the simulated particle shower footprints, which were then analyzed using machine learning models. These models were trained to predict the incoming particle angle with high precision, utilizing the rich spatial and temporal information available in the simulated datasets. Our results demonstrate the feasibility of accurately reconstructing the directionality of cosmic rays, a key requirement for studying astrophysical sources. These findings not only validate the proposed capabilities of the CONDOR observatory but also highlight the potential of integrating machine learning methodologies in cosmic ray research.

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