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Graph Neural Networks for Photon Search with the Underground Muon Detector of the Pierre Auger Observatory (Remote)

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Ultra-high-energy (UHE) photons are expected as by-products of cosmic-ray acceleration, propagation, or decay of super-heavy dark matter particles. Predicted diffuse photon fluxes are usually several orders of magnitude below the UHE cosmic-ray flux. This contribution presents a method for discriminating photon-initiated air showers in the overwhelming cosmic-ray background with the Pierre Auger Observatory. The method leverages information from both the Surface Detector (SD), consisting of water-Cherenkov detectors (WCDs) and the Underground Muon Detector (UMD). We use graph neural networks, that allow the encoding of the input information acquired by the SD and UMD. The approach is particularly suitable for handling the irregular geometries of the SD and UMD arrays, where stations may be temporarily missing due to technical issues. Using simulations, the performance estimates indicate that the method has a strong potential for identifying photons at UHE.

Type of Contribution

talk

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