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New method for Gamma/Hadron separation in HAWC using neural networks

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The High Altitude Water Cherenkov (HAWC) gamma-ray observatory is located at an altitude of 4100 meters in Sierra Negra, Puebla, Mexico. HAWC is an air shower array of 300 water Cherenkov detectors (WCDs), each with 4 photomultiplier tubes (PMTs). Because the observatory is sensitive to air showers produced by cosmic rays and gamma rays, one of the main tasks in the analysis of gamma-ray sources is gamma/hadron separation for the suppression of the cosmic-ray background. Currently, HAWC has a method called Compactness for the separation, but this method divides the data into 10 bins that depend on the number of PMTs in each event, and each bin has its own value cut. In this work, we present a new method that has only one bin, and therefore one cut for gamma/hadron separation. The method uses a Multilayer Perceptron net (MLP) that is fed with 5 features of the air shower to create one output value. We used simulated cosmic-ray and gamma-ray events and did an analysis to find the optimal cut and then applied the technique to data from the Crab Nebula. We found that the MLP method has superior gamma/hadron discrimination power when compared to Compactness, resulting in a 17% increase in the maximum significance of the excess of gamma rays from the Crab Nebula.

Collaboration

HAWC

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610

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