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A high-level analysis framework for HAWC

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The High Altitude Water Cherenkov (HAWC) Observatory continuously observes an instantaneous field of view of about 2 steradians above the array for gamma-rays between 100 GeV to 100 TeV. The large amount of raw data, the importance of small number statistics, the large dynamic range of gamma-ray signals in time (1 – 10ˆ8 sec) and angular extent (0.1 –100 degrees), and the growing need to directly compare results from different observatories pose some special challenges for the analysis of HAWC data. To address these needs, we have designed and implemented a modular analysis framework based on the method of maximum likelihood. The framework facilitates the calculation of a binned Poisson Log-likelihood value for a given source model, data set, and detector response. The parameters of the source model (sky position, spectrum, angular extent, etc.) can be optimized to obtain a best match to the data. In a similar way, the parameters of the detector response (absolute pointing, angular resolution, etc.) can be optimized using a well-known source such as the Crab Nebula.

Our software for defining a source model was designed concurrently with the Multi-Mission Maximum Likelihood (3ML) architecture, and allows for the definition of a general collection of sources with individually varying spectral and spatial morphologies. Compatibility with the 3ML architecture allows to easily perform powerful joint fits with other observatories. In this contribution, we describe the design and capabilities of the HAWC analysis framework and the applicability of the framework design to other VHE observatories. We present verification of the HAWC detector response using the point-like Crab Nebula as a reference. As a demonstration, we show the first fit of the Crab spectrum using low-level data from two observatories: HAWC and Fermi-LAT.

Collaboration

HAWC

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