

Study of the morphology of the region surrounding eHWC J1850+001

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Although at extreme energies (>50 TeV) γ -ray sources generally have large angular separations from one another as observed on Earth, at lower energies in the galactic plane this is often not the case. HAWC observes extended emission from the source eHWC J1850+001 exceeding 50 TeV, and at lower energies this region appears to consist of multiple sources of γ -ray emission. These include the 3HWC J1849+001 source but also two nearby H.E.S.S. sources observed in their Galactic Plane Survey. Therefore, a full description of the region requires a morphological study including the full energy range of HAWC data. Understanding the spatial features of the emission in this region is important to associate the sources observations at other wavelengths, which may point to hadronic or leptonic origins for the γ -ray emission. There are multiple pulsar wind nebulae and super nova remnant systems in the vicinity that may be responsible for the emission in this region, including the pulsar PSR J1849+001 and its pulsar wind nebula, which is a likely candidate for the >50 TeV energy emission seen by HAWC.

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1. Introduction

The VHE source eHWC J1850+001 was identified to emit significant flux above 50 TeV and was fit with a Gaussian extent of $0.37^\circ \pm 0.16^\circ$ [1]. However, in the region surrounding eHWC J1850+001, significant emission has been observed at lower energies in the High Energy Stereoscopic System (H.E.S.S.) Galactic Plane Survey (hereafter HGPS) and previous catalogs¹ from the High Altitude Water Cherenkov (HAWC) Collaboration [2–4]. Unlike the HGPS, the 2HWC and 3HWC did not provide a detailed description of the morphology and spectrum of the region, instead using a more simplistic search for isolated sources, both point-like and extended [2, 3]. The 3HWC search found four sources in the region, with the HGPS reporting three. With the context of this high energy detection, and multiple sources in the region at lower energies in those catalogs, a detailed investigation of the region testing the likelihood of different models is needed to better interpret the HAWC data.

The H.E.S.S. Collaboration in the HGPS identified several (potential) counterparts to the 3 sources it observed in the region [4].

- HESS J1849-000
 - Gaussian morphology: $0.09^\circ \pm 0.015^\circ$ extent
 - Associated with PSR J1849-0001 and PWN G32.6+0.5
- HESS J1852-000
 - Gaussian morphology: $0.28^\circ \pm 0.042^\circ$ extent
 - Potential Associations:
 - * SNR G32.8-0.1
 - * SNR G33.2-0.6
 - * PSR J1853+0011
 - * PSR J1853-0004
- HESS J1848-018
 - Gaussian morphology: $0.25^\circ \pm 0.032^\circ$ extent
 - Possible Associations:
 - * Starburst region W43
 - * 3FGL J1848.4-0141

In the case of HESS J1852-000, the extent reported in the HGPS is larger than the spatial distribution of the potential sources, and only an instrument with superior angular resolution to HESS and HAWC is likely to enable a firm association to be made at TeV energies. However, for HESS J1848-018 the possible association with W43 might be confirmed with a hard spectrum extending to 100 TeV, indicating the presence of a hadronic accelerator.

¹The 2HWC and 3HWC catalogs [2, 3]

2. Data & Methods

The data used in this study comprises 1343 days of HAWC data, representing 305 days more exposure than the analysis presented in [1]. This analysis is performed using all reconstructed data above 1 TeV. The model for the region is developed iteratively. First an empirical model for the diffuse emission is defined assuming a Gaussian function of galactic latitude with a fixed width of 1° , and a power law spectrum with an index fixed at -2.75 . The normalization is left free. Next, an extended source is added with a Gaussian morphology and power law spectrum with all parameters free. This process then repeated until no additional sources were found. In the case of the source near the location of the prior eHWC J1850+001 source, the addition of other extended sources caused it to converge to a small extent. In this paper, the source (hereafter referred to as HAWC J1849) is presented as a point source.

3. Results

The model presented here consists of 3 sources (HAWC J1849 and two extended sources) and an empirical fit for the galactic diffuse emission. The spectrum for HAWC J1849 matches well with the spectrum for HESS J1849-000 in the HGPS[4] (as can be seen in Figure 1). From the model presented here, incorporating multiple extended sources, it seems likely that the eHWC J1850+001 extent of $0.37^\circ \pm 0.16^\circ$ was due to source confusion and it is more likely well-fit as a point source [1].

4. Conclusions

The good agreement thus far in the spectrum between HESS J1849-000 and HAWC J1849 is encouraging, and points toward further refinement of the model converging to a much clearer description of the region than previously presented in any HAWC analysis. Additionally, a follow-up study using Fermi-LAT data will explore the possibility of other possible associations near W43 for the TeV emission. Further steps to be taken using HAWC data is running the analysis on an update of the HAWC reconstruction with improved core reconstruction, γ /hadron separation, and low energy response. This will allow for a better look into this complex region of the galaxy.

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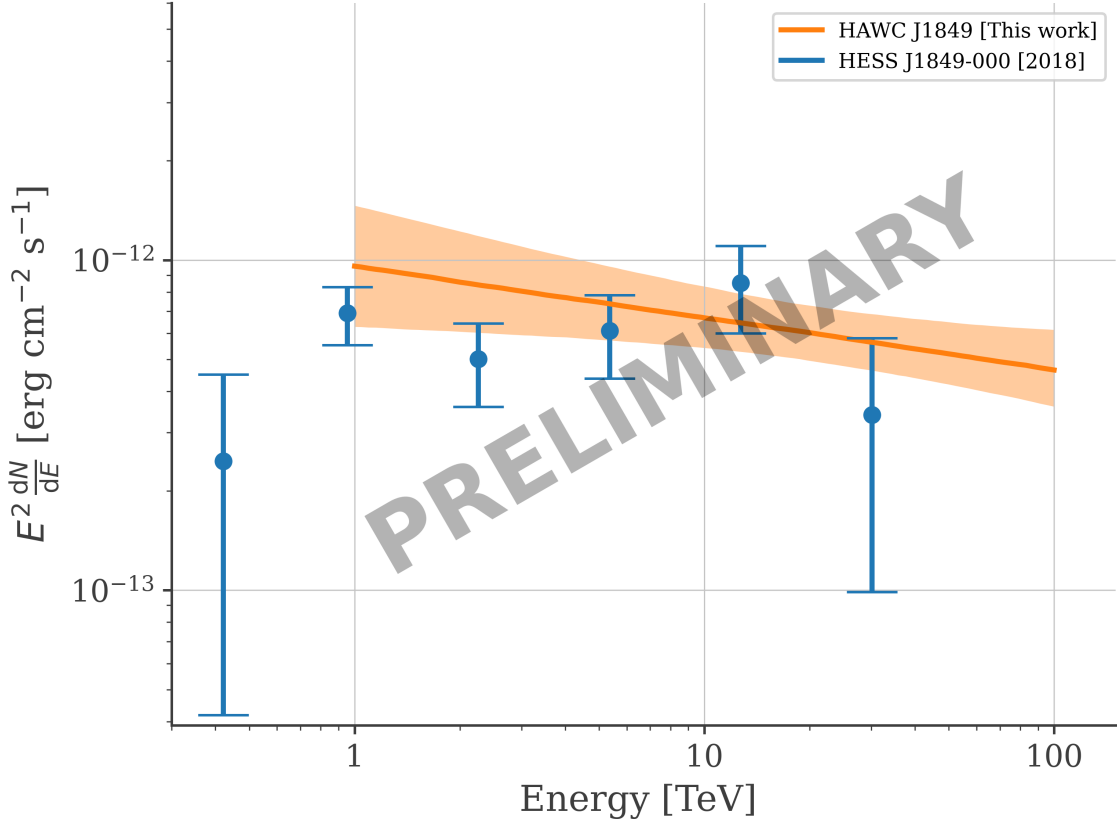


Figure 1: Spectrum of HAWC J1849 fit with a point source morphology. Spectral points from HESS J1849-000 taken from [4].

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