Spectral and Energy Morphology Analysis Study of HAWC J2031+415

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ABSTRACT

The Cygnus Cocoon region is a complex region containing an OB star cluster that is prominent in the TeV energy range. Located in this region is 3HWC J2031+415, a significant TeV gamma ray source whose emission is possibly associated with 2 components, the Cygnus OB2 star cluster and a pulsar wind nebula (PWN). In this work, several modelling methods are presented to best describe the emission. These models disentangle emission believed to be from the Cocoon and isolate the component emitted by the probable PWN. I will present several spectral models to describe the emission of the probable PWN using the latest data set from the High-Altitude Water Cherenkov (HAWC) observatory. Furthermore, I will present an energy morphology study of the PWN component of 3HWC J2031+415 in distinct energy bands.

INTRODUCTION

3HWC J2031+415 is located in the Cygnus Cocoon region, a complex region of star clusters and stellar associations [2]. It has been found through a previous HAWC analysis that 3HWC J2031+415 is comprised of 2 sources: HAWC J2030+409 (Cocoon emission visible to HAWC) and HAWC J2031+415, a probable PWN [1]. This study presents an in-depth analysis into HAWC J2031+415's spectrum and it's energy morphology.

METHODS

HAWC J2031+415 is analyzed using a multi-source fit using 3 sources: itself, HAWC J2030+409, and 3HWC J2020+403, an SNR in close proximity to HAWC J2031+415. This fit determines HAWC J2031+415 is an extended, symmetric Gaussian source with a cutoff power law spectrum with E_c in the tens of TeV. The energy morphology study is conducted by taking a longitudinal profile of HAWC J2031+415's emission after the other two sources have been subtracted out. The excess counts are then found, a 1D Gaussian is fitted to the profile, and the source extension is determined.

CONCLUSION

This study determines that HAWC J2031+415 is well modelled with a extended, symmetric Gaussian with a cutoff power law. This spectral description with HAWC's newest data matches HAWC's previous work [1]. The energy morphology of HAWC J2031+415 is then determined, though it is inconclusive; a slight trend can be observed in decreasing morphology with increasing energy but more data is needed before any conclusions can be drawn.

REFERENCES

[1] Abeysekara, A.U., Albert, A., Alfaro, R. et al. "HAWC observations of the acceleration 117 of very-high-energy cosmic rays in the Cygnus Cocoon." Nat Astron 5, 465-471 (2021).

[2] A. Albert et al "3HWC: The Third HAWC Catalog of Very-high-energy Gamma-Ray Sources" 2020 ApJ 905 76