

Investigating the Acceleration Potential of a Star Forming Region with 2HWC J2031+415

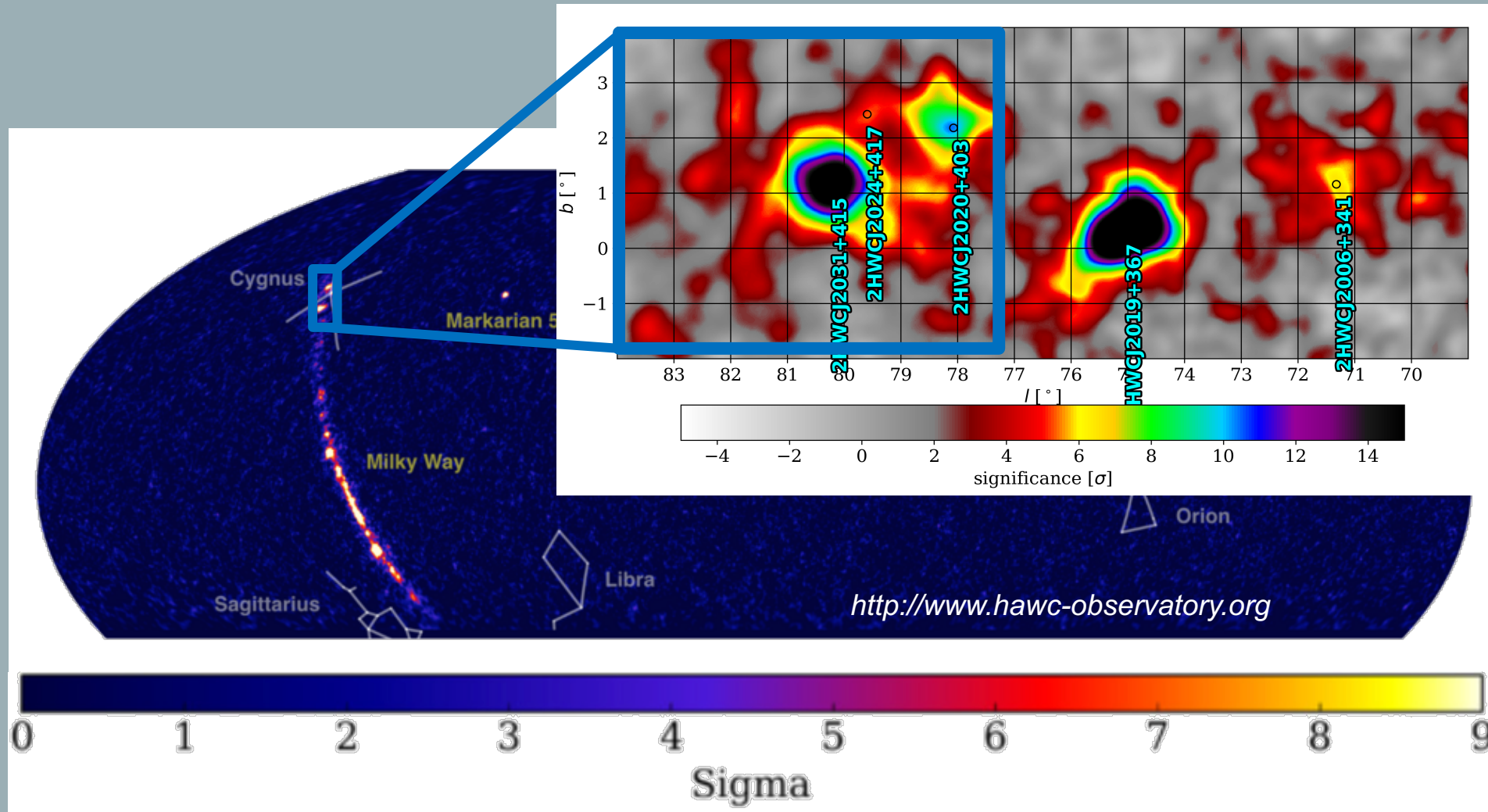


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Fermi Summer School, 2018

High Altitude Water Cherenkov Observatory



Gamma-Ray Sky with HAWC

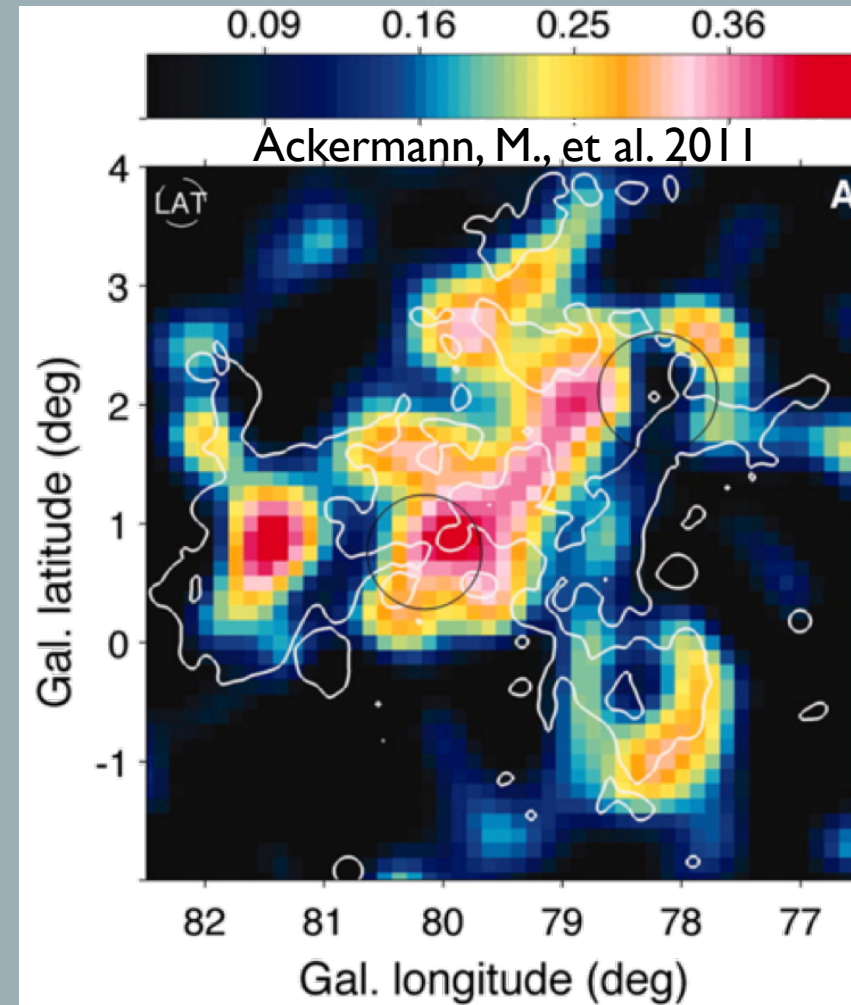


Star Forming Regions (SFRs)

- Supernova Remnants (SNRs) as main source of cosmic rays (CRs) in our Galaxy
- SFR as another possible source of CRs in our Galaxy
- CR acceleration mechanisms in SFRs:
 - Proto-stars
 - Collective stellar winds
 - SNRs
- OB2 association in the Cygnus region near 2HWC J2031+415

Fermi-LAT Cocoon

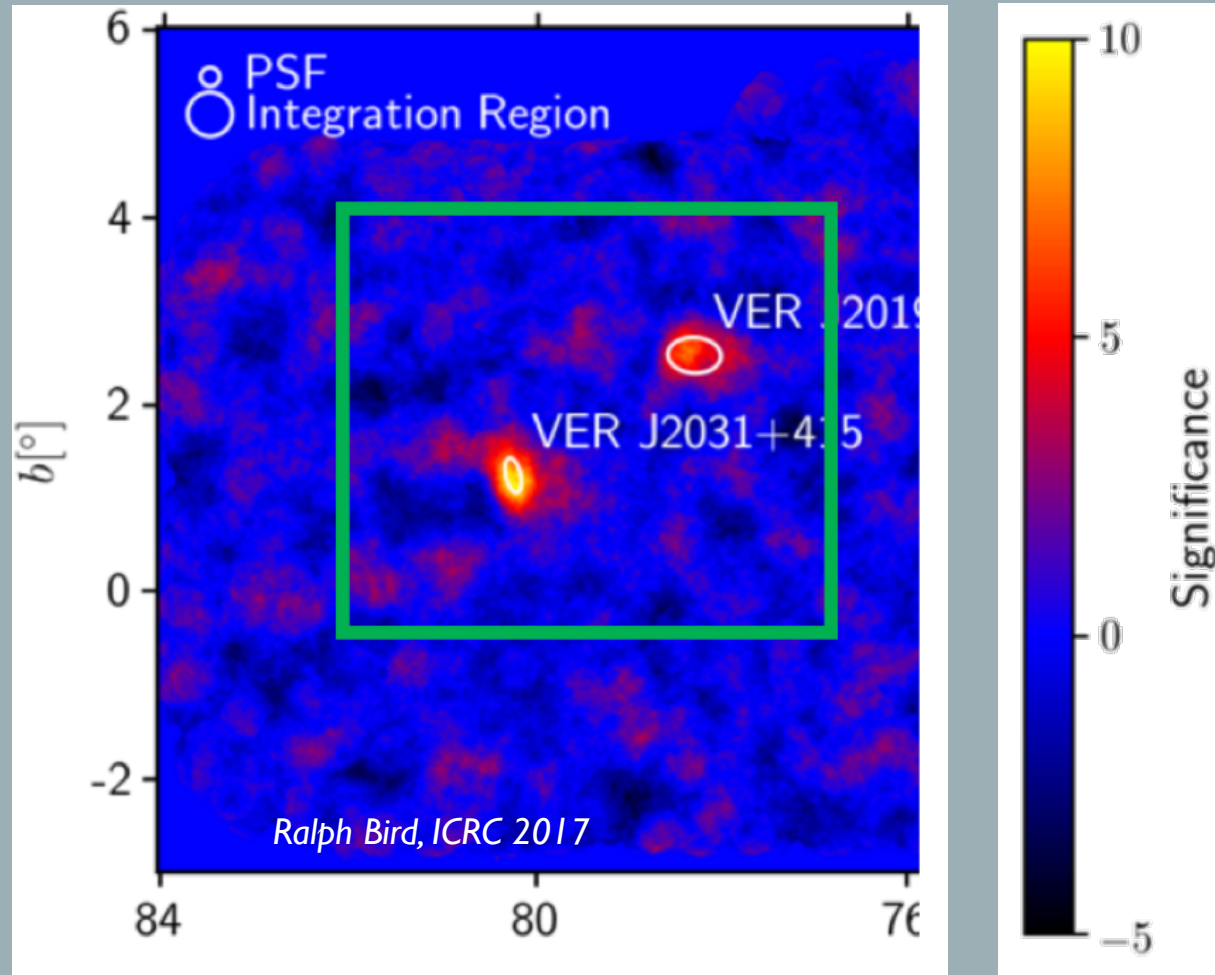
- Attributed due to a Cocoon of freshly accelerated Cosmic Rays
- Powered by Supernova Remnant or Star forming region?
- Evidence of star forming region as GCR accelerator
- Unique and only seen at GeV energies – no TeV counterpart so far



photons/bin
Fermi-LAT Residual Photon Count Map

VERITAS source VER J2031+415

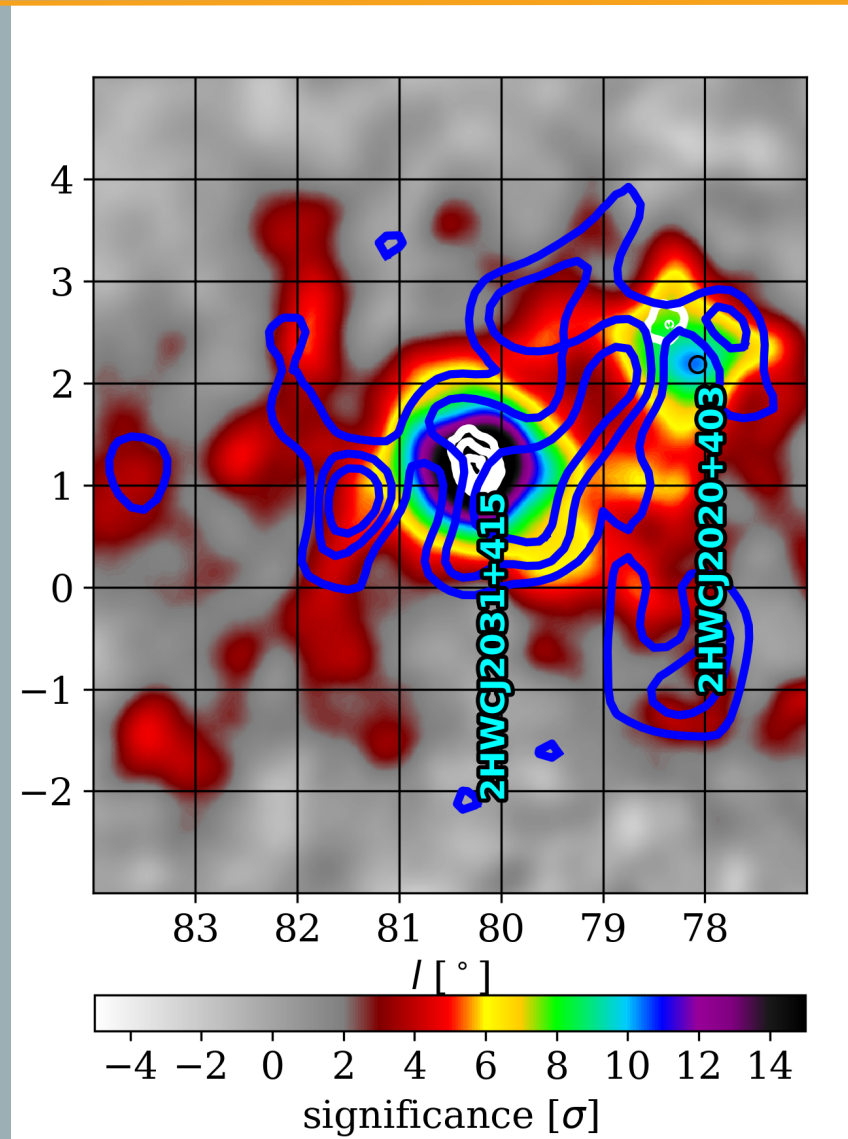
- Probably a pulsar wind nebula (PWN)
(Aliu, E., et al., 2014)
- PSR J2032+4127 in long-period orbit around a Be star
(Lyne, A. G., et al. 2015)



VERITAS Significance Map of the Region

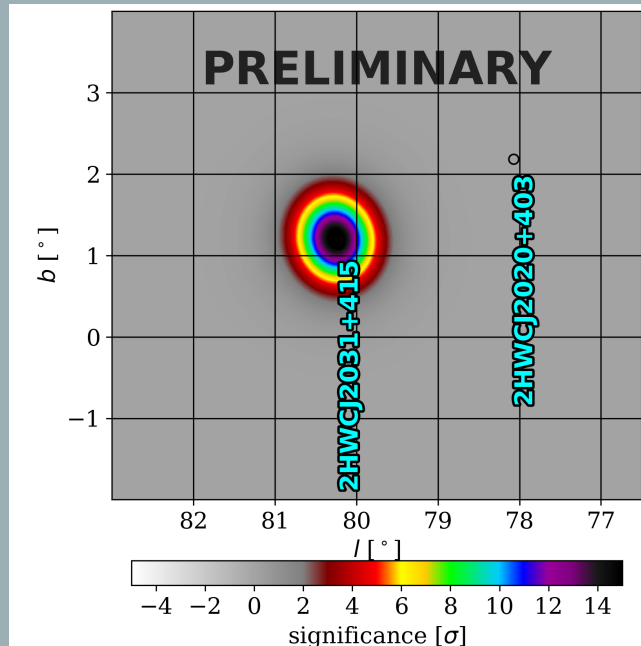
HAWC Map of the Cocoon Region

- Significance map with 1017 days of HAWC data
- **White contours:** VERITAS 5,7 and 9 significance contours
- **Blue contours:** Fermi-LAT 0.16, 0.24, 0.32 photons per bin contours

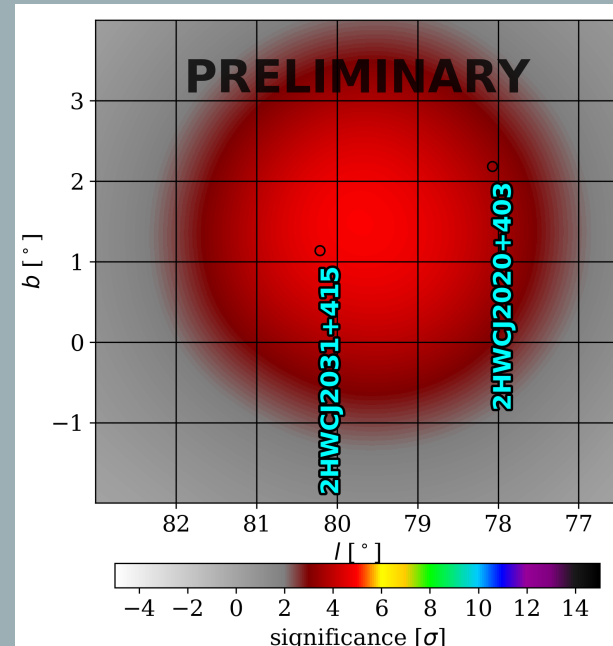


Multi-Source Fit at the Cocoon Region using 3ML

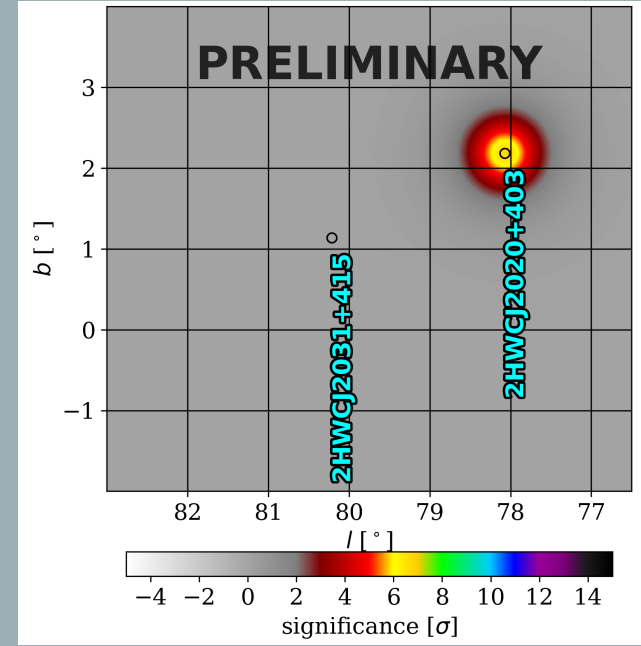
- Ingredients for a multi source fit
- VER J2031+415 (included as the background) + Likely Cocoon counterpart + 2HWC J2020+403



VER J2031+415



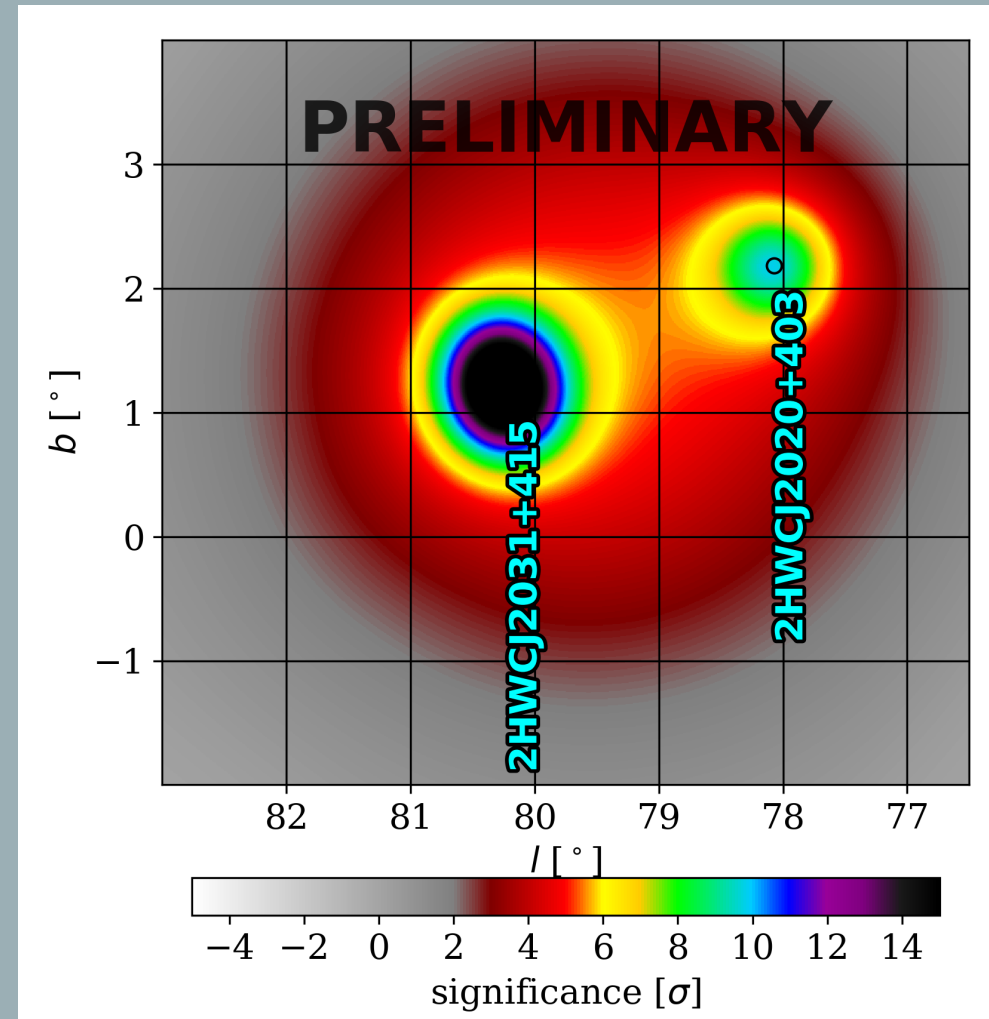
2D Gaussian HAWC Cocoon
Spectral Model: Power law with
an exponential cut off



2HWC J2020+403
Spectral Model: Power law

Multi-Source Fit at the Cocoon Region

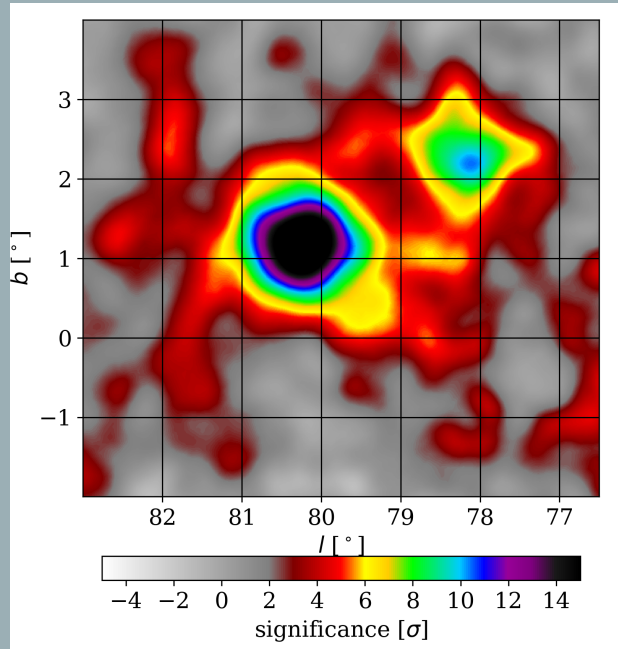
- Complete model map of the region using Power law spectrum with exponential cutoff



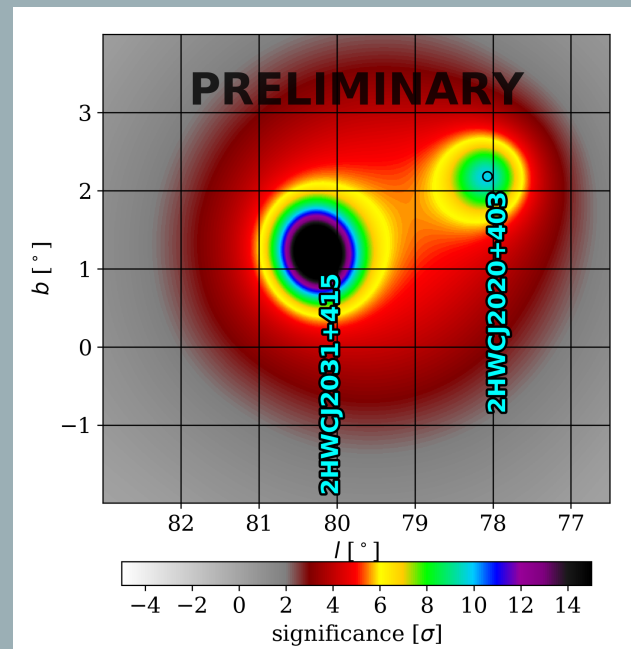
Model map of the Region

Multi-Source Fit at the Cocoon Region

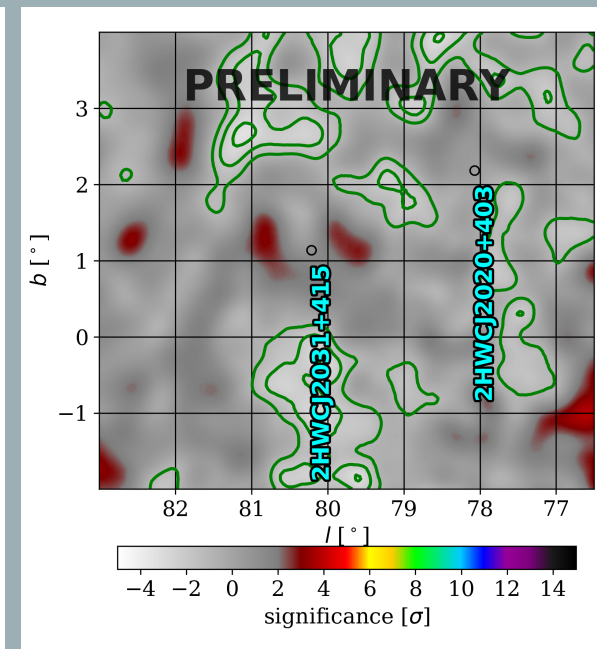
- A good description of TeV gamma-ray emission in the region



Data Map

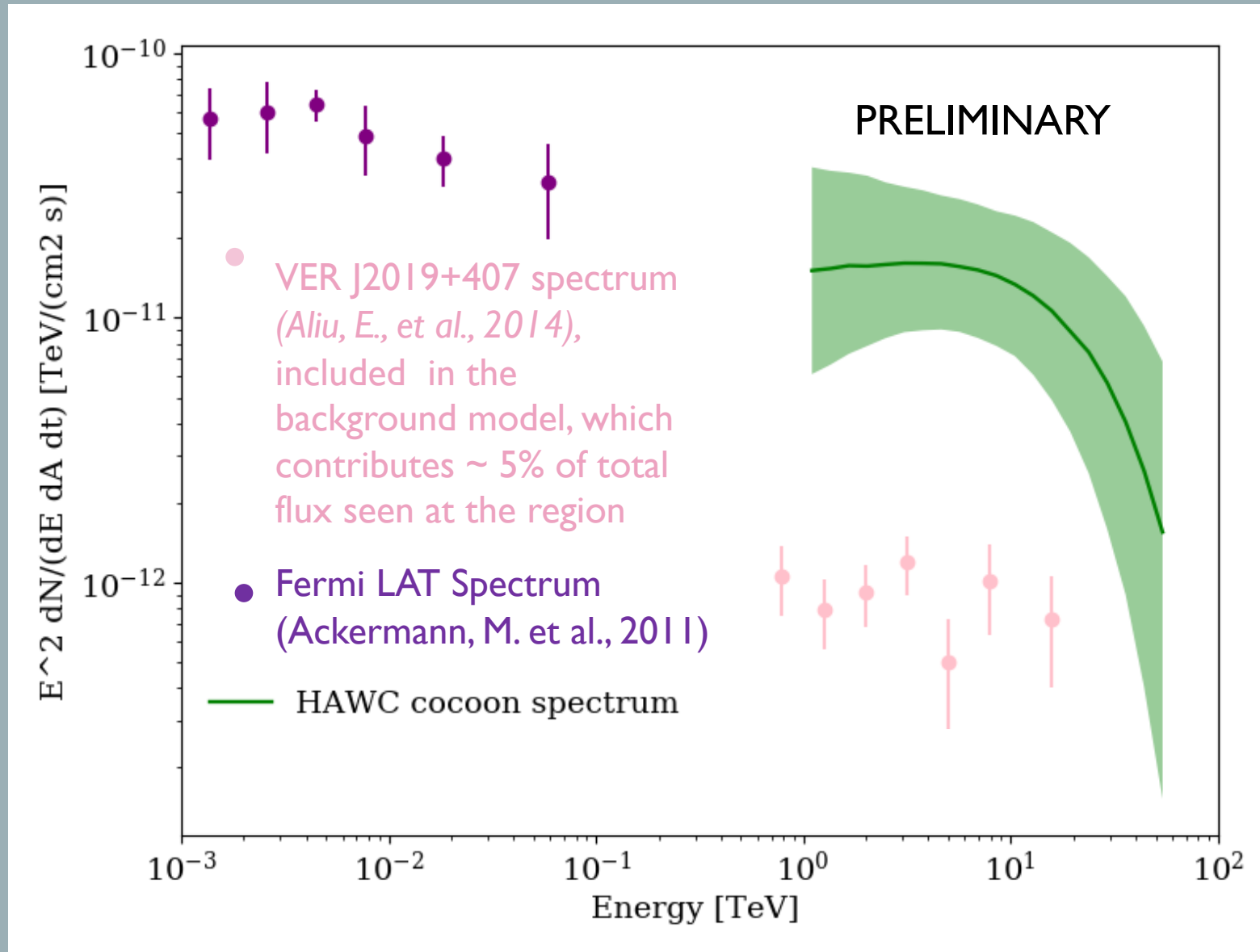


Model Map



Residual Map
(with -1, -2, -3, -4 contours)

Gamma Ray Spectra in the Cocoon Region



Conclusion

- HAWC multi-TeV data of the 2HWC J2031 region is compatible with the Fermi-Lat discovery of a cocoon of freshly accelerated CRs
- HAWC cocoon favors power law spectrum with exponential cutoff

Future Work

- Combined analysis of HAWC and Fermi-LAT data with 3ML software
- Constrain maximum energy of the cosmic ray spectrum in the cocoon

Thank you Fermi School!



6/5/18