

A History of Science in Latin America (INTD290): Unit 2

Jordan Hanson

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Whittier College Department of Physics and Astronomy

Introduction: Gamma Ray Astrophysics

Introduction: Gamma Ray Astrophysics

1. What is a high-energy gamma ray?

- Units of energy
- Types of particles
- Air showers
- Astrophysical sources

2. How do we detect them?

- The Cherenkov effect in water
- Water-based detectors and photo-multiplier tubes (PMTs)

3. Who detects them?

- International collaborations of scientists
- Detectors located in New Mexico, Mexico, and Chile

Energy units, Particle types, Air
Showers, Astrophysical Sources

Introduction: Gamma Ray Astrophysics

1. What is a high-energy gamma ray?

- Units of energy
 - Units: electron-Volts (1.6×10^{-19} J), GeV, TeV, ...
 - Flux: particles per unit area, time, 2D angle on sky, ...
- Types of particles
 - Gamma rays: γ -ray (photon with energy greater than 1 MeV)
 - Electrons: e^- (negative charge, mass is 511 keV)
 - Positrons: e^+ (positive charge, mass is 511 keV)
 - Muons: μ^\pm (negative or positive, mass is 0.106 GeV)
 - Neutrinos: ν (neutral, basically massless)
- Air showers
- Astrophysical sources

Introduction: Gamma Ray Astrophysics

1. Air showers - High energy particles hit the atmosphere and make other particles.
2. Astrophysical sources

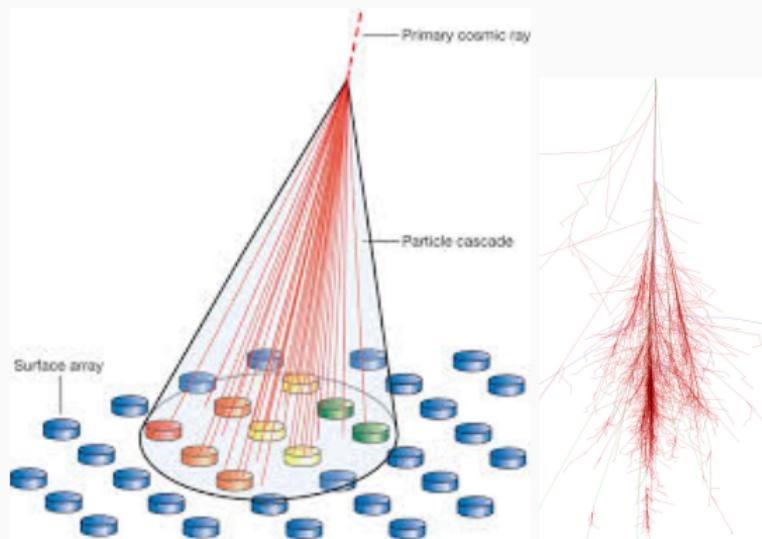


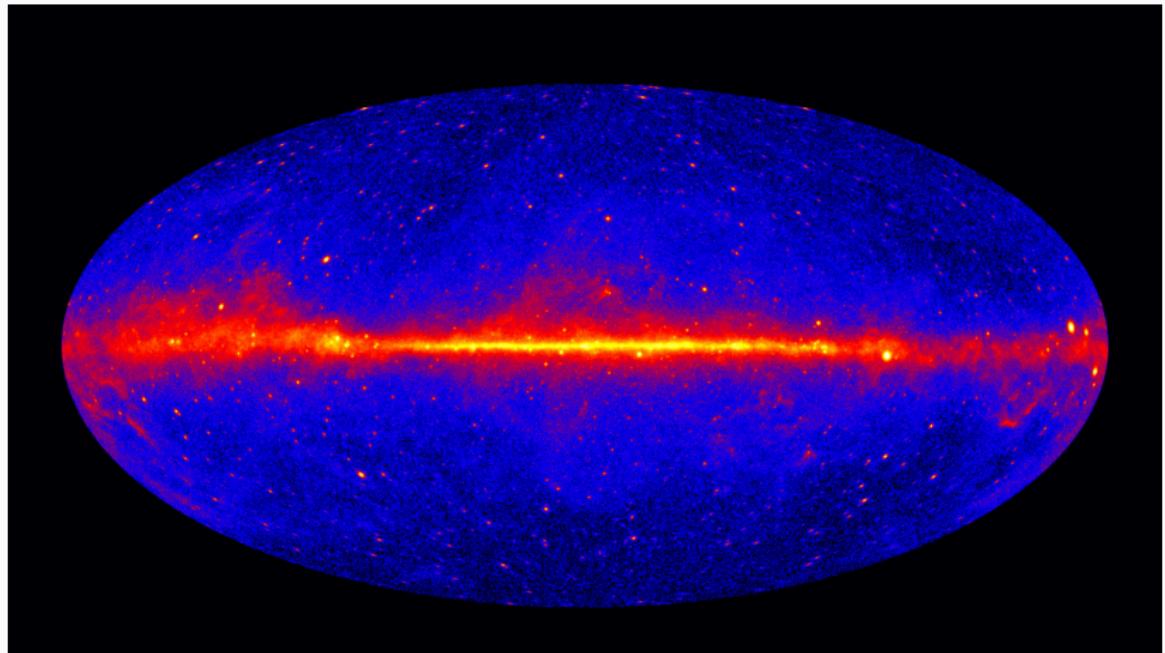
Figure 1: High-energy particles hit the atmosphere.

Introduction: Gamma Ray Astrophysics

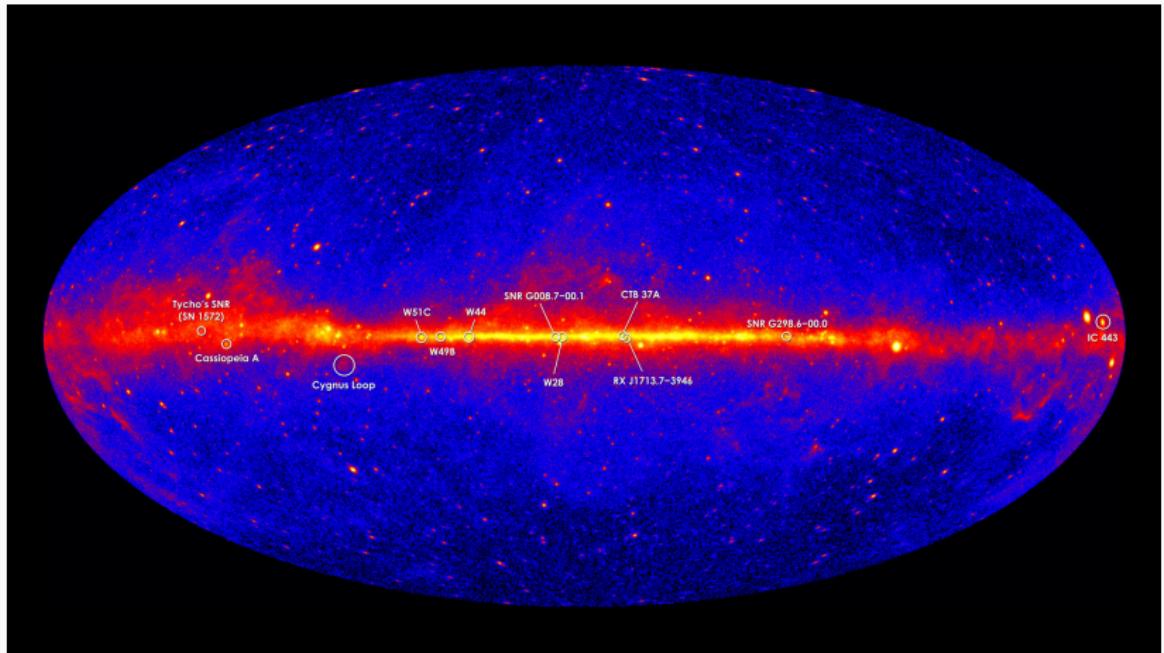
1. Air showers
2. Astrophysical sources ...

What do we put here ...

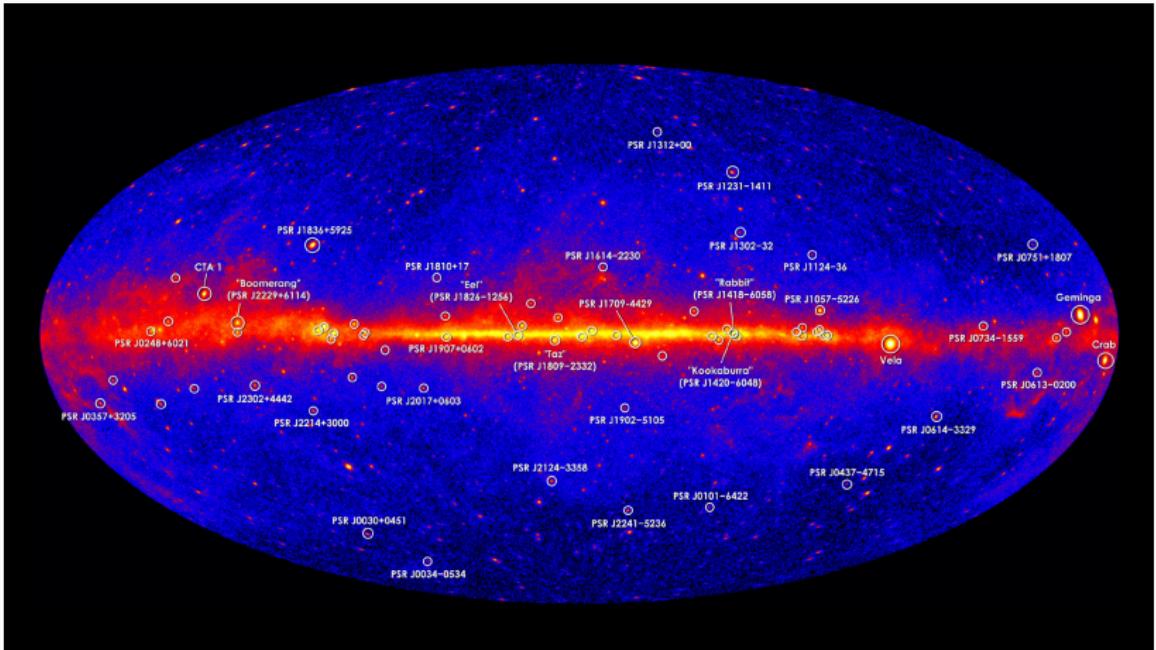
Introduction: Gamma Ray Astrophysics: All



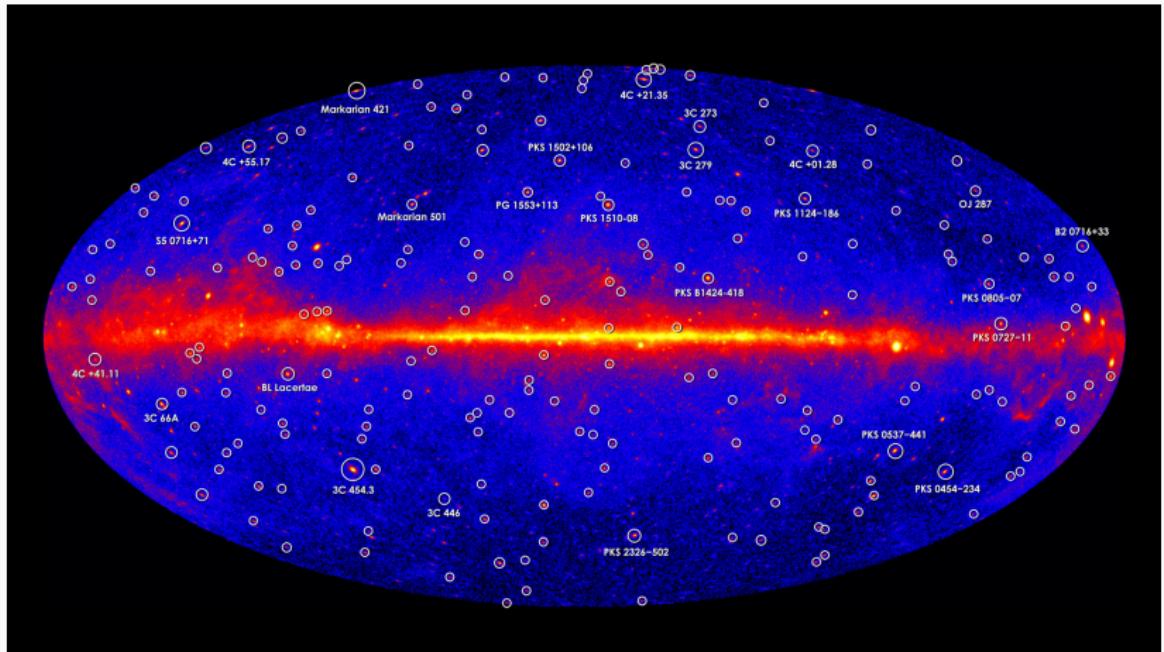
Introduction: Gamma Ray Astrophysics: Supernova



Introduction: Gamma Ray Astrophysics: Pulsars

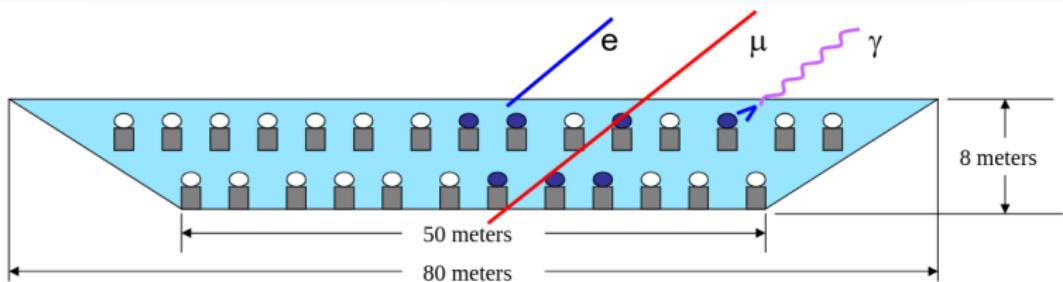
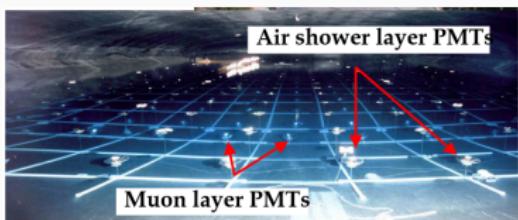


Introduction: Gamma Ray Astrophysics: Black Holes

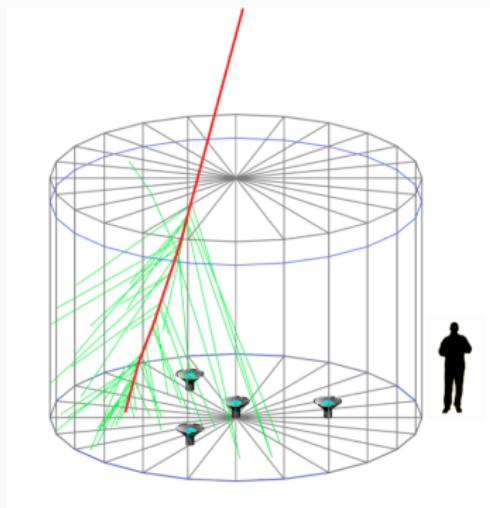


How do we detect them?

How we detect them: Water-based Cherenkov Radiation



How we detect them: Water-based Cherenkov Radiation



Who detects them?

Who detects them?

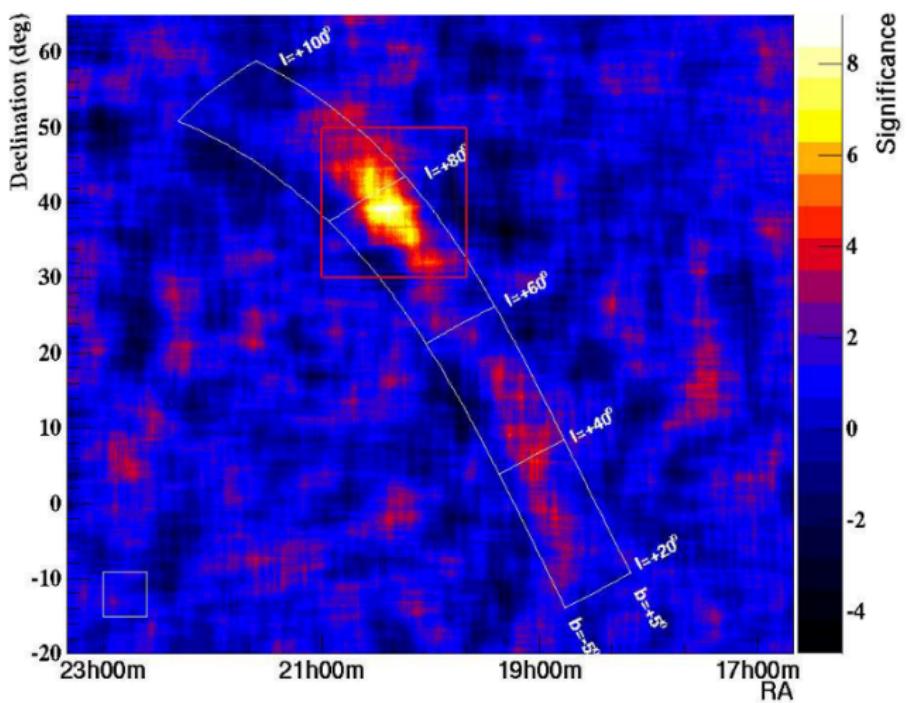


Figure 2: Milagro: a gamma-ray observatory in Los Alamos, NM.
Pictured: Cygnus Region.

Who detects them?

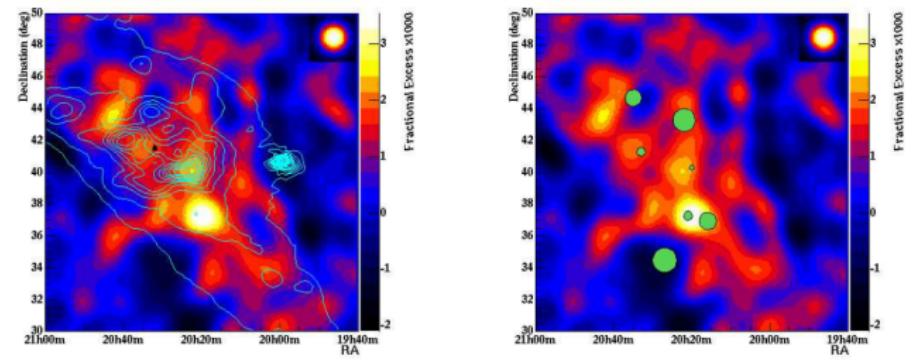


Figure 3: Milagro: a gamma-ray observatory in Los Alamos, NM.
Pictured: Cygnus Region.

Who detects them?

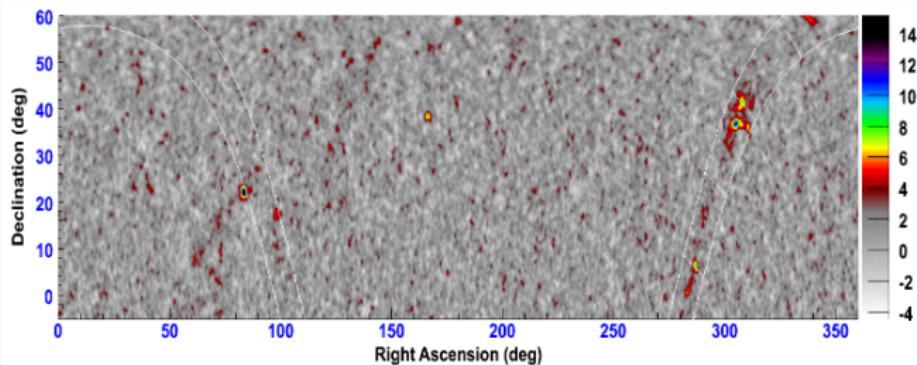
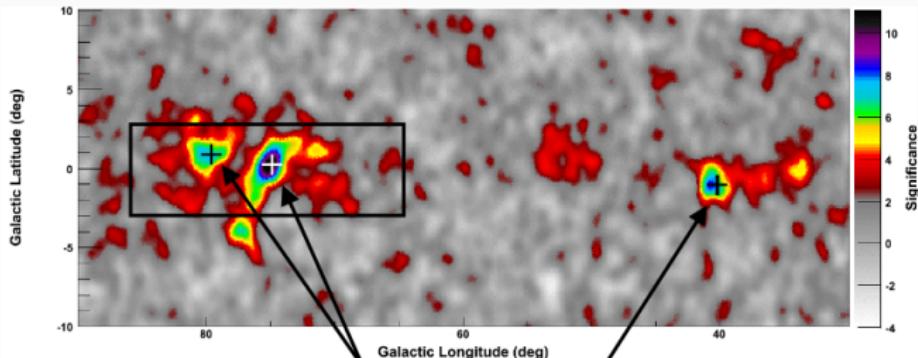


Figure 4: Milagro: a gamma-ray observatory in Los Alamos, NM.
Pictured: Cygnus Region.

Who detects them?



- Cygnus region shows two new TeV gamma-ray sources
- Diffuse emission from Cygnus region
- A new TeV source at low declinations

Figure 5: Milagro: a gamma-ray observatory in Los Alamos, NM.
Pictured: Cygnus Region.

Who detects them?



Figure 6: HAWC: High Altitude Water Cherenkov detector.

Who detects them?



Who detects them?

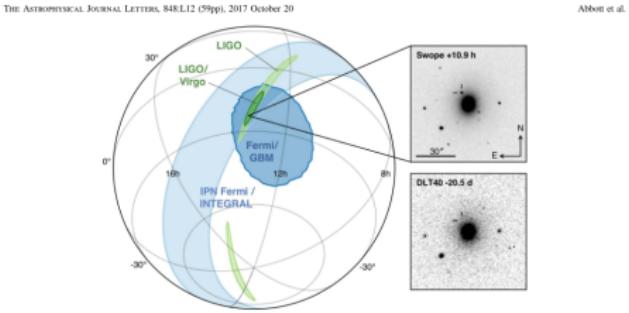
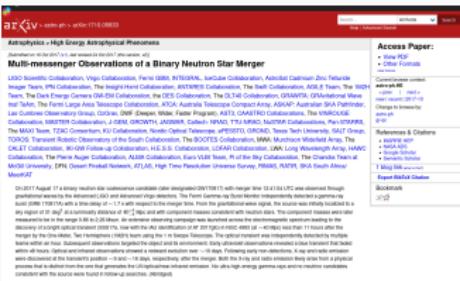


Figure 8: HAWC: High Altitude Water Cherenkov detector.

Who detects them?

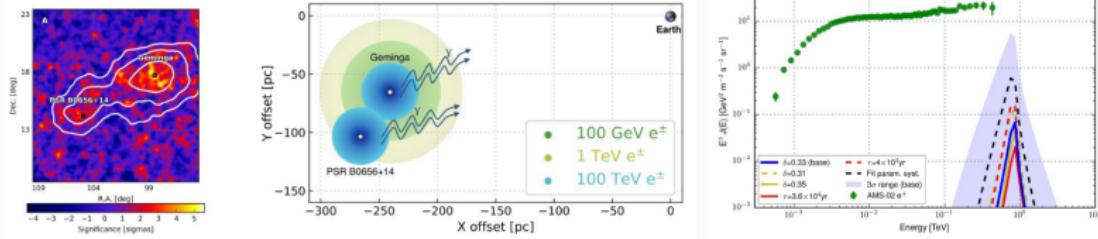
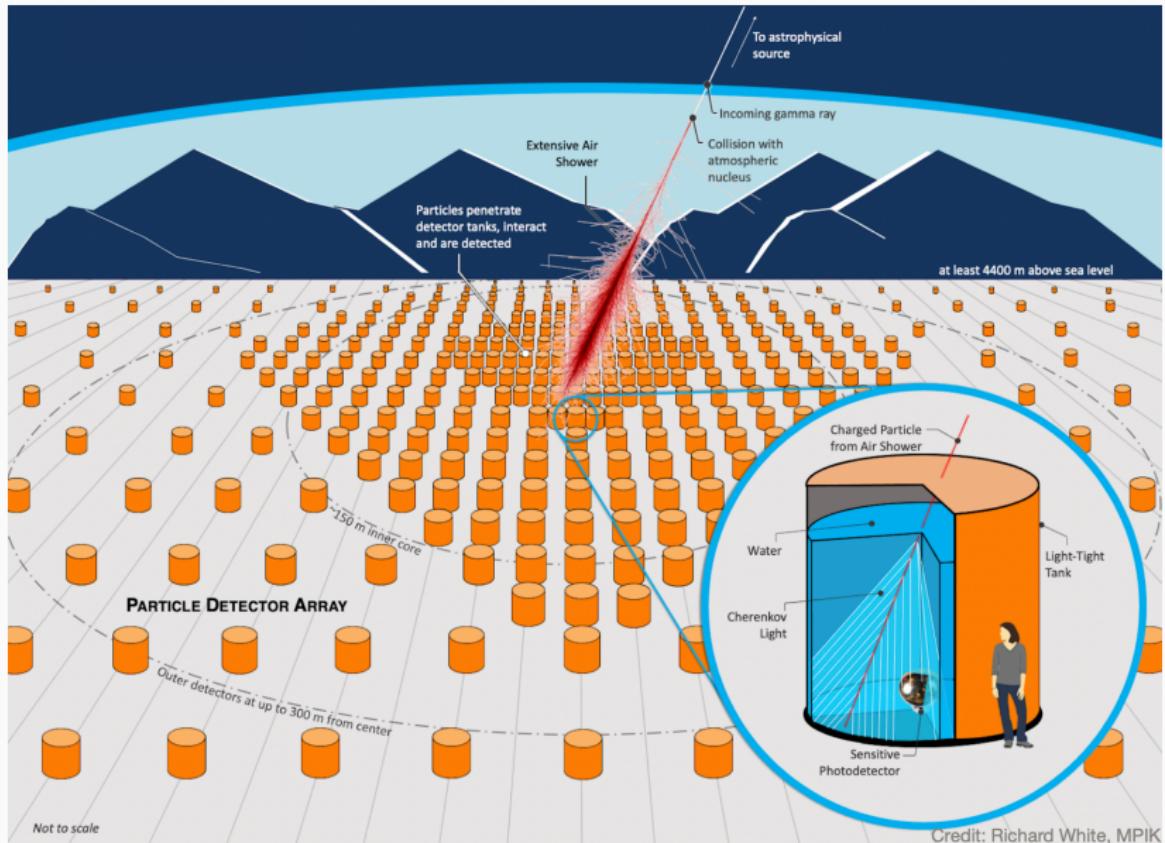


Figure 9: HAWC: High Altitude Water Cherenkov detector.

SWGO: Southern Wide Field Gamma-ray Observatory



Credit: Richard White, MPIK

Conclusion

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