The (Indirect) Search for Dark Matter: From Theory to Experiment

By Lina Pulgarin-Duque
Outline

- VERITAS & Cherenkov Telescopes
- Cherenkov Radiation & Gamma Rays
- Dark Matter
- CTA
- Mirror Alignment
- Motion Controller
- Scanning in a grid
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VERITAS

- 4 Atmospheric Cherenkov Telescopes
- Aperture 12m
- Can detect energies from 50 GeV to 50 TeV
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Cherenkov Radiation

http://www.mpi-hd.mpg.de/hfm/CosmicRay/Showers.html
Cherenkov Radiation in our Atmosphere
Observe Gamma Rays

Miles overhead, very-high-energy gamma rays enter the atmosphere and collide with air molecules. These collisions produce a shower of secondary particles that move towards the ground at nearly the speed of light. The VERITAS cameras image the faint blue/ultraviolet glow emitted by these “air showers”. This pulse of Cherenkov light lasts only a few billionths of a second.

The telescope in front of you is one of four in an array. Using four telescopes rather than just one enables the direction and energy of each gamma ray to be determined more accurately and to reject numerous charged particles that act like noise in the observation.

Each telescope views the air shower from a different perspective and the resulting images have different orientations. The position in the sky of a gamma-ray source can be determined from the intersection of lines drawn through each image.
Observing Gamma Rays
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Dark Matter

- What is Dark Matter
- Dark matter annihilation
- Decay with time
On/Off Regions
FIG. 1. Comparison of the Galactic DM halo profiles used in this analysis. The parameters for the NFW and Einasto profiles are taken from [25]. An isothermal profile [24], exhibiting a flat DM density out to a galactocentric distance of 1 kpc, is shown for comparison. All profiles are normalized to the local DM density ($\rho_0 = 0.39$ GeV/cm$^3$ [26] at a distance of 8.5 kpc from the GC). The source region and the region used for background estimation are indicated. Note that the predicted DM density is always larger in the source region, except for the isothermal profile, which is included for completeness.
Upper Limit on Dark Matter Annihilation

● VERITAS & Cherenkov Telescopes
● Cherenkov Radiation & Gamma Rays
● Dark Matter
● CTA
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● Motion Controller
● Scanning in a grid
- A lot more telescopes
- Will detect energies from 30 GeV to 100 TeV
- Aperture sizes will vary

Courtesy of CTA
CTA Schwarzschild-Couder

Courtesy of Daniel Nieto
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Mirror Alignment

Primary

Secondary

Courtesy of CTA
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Motion Controller
Lab Setup
RS232 Cable
USB Cable
RS232-USB Cable
RS232-USB cable
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UCLA Code

- Move motion controller & pistons remotely
- Scan the opal glass
- Scan the opal glass in a grid
- Run a code at every grid point
- Save files and logs in a sensible folder structure
- Analyze data
Scanning in a Grid
Capturing in a grid
Capturing in a grid
Analyzing the pictures

Graph

Graph

Histogram of Residuals

Full X: Burst Sigma at Each Point (pix)

Full Y: Burst Sigma at Each Point (pix)

Graph

Graph

Graph

Histogram of Residuals
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