Measurements of Cosmic Ray Muon Flux During April 8th Eclipse

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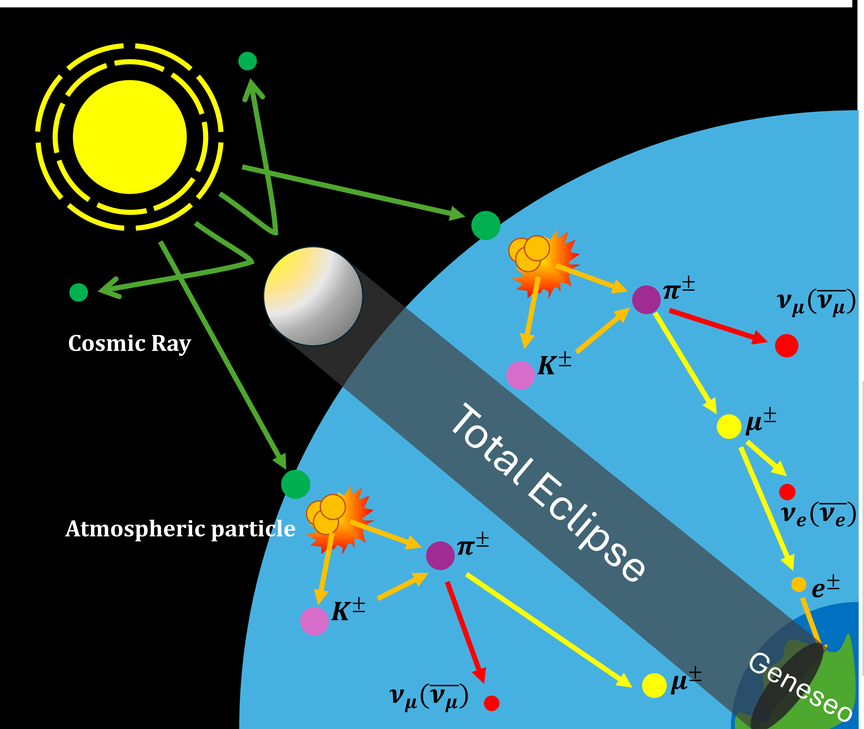
Abstract

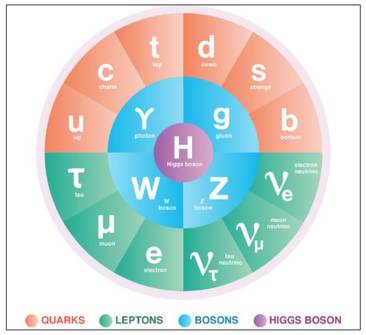
Muons are one of the fundamental particles of the universe. They share many properties with electrons, like charge, but are 200 times more massive. Muons are produced naturally when highly energetic particles originating from the sun or from within distant galaxies, interact with the upper atmosphere of the earth. Each one of these highly energetic particles produces a shower of highly energetic and penetrative muons that rain down on the surface of the earth. Using the TeachSpin Muon Physics Apparatus, measurements of the rate at which muons reach the surface of the earth have been made. These measurements show a decrease in the count rate during the night when cosmic ray muons produced by the sun are blocked by the earth. An Experiment was conducted at SUNY Geneseo to measure the muon count rate during the April 8th total Eclipse.

The Cosmic Cascade



What are Muons?

The Standard Model of Particle Physics is a table that categorizes the fundamental particles of the universe. One of these particles is called the muon. Like the electron, the muon is negatively charged, but is ~200 times more massive. Atmospheric muons are created when high energy particles from space, called cosmic rays, collide with particles in earth's atmosphere. A fraction of the cosmic rays that strike the earth come from the sun. The particles break apart in a "cosmic cascade", one of the byproducts being the muon.



Standard model diagram sourced from the Department of Energy website: energy.gov

Expectations: If the number of muons that strikes the earth fluctuates with Earth's day/night cycle, then the number of muons during the eclipse should be like that of nighttime

Important decays

$$\pi^{\pm} = \mu^{\pm} + \nu_\mu(\overline{\nu_\mu})$$

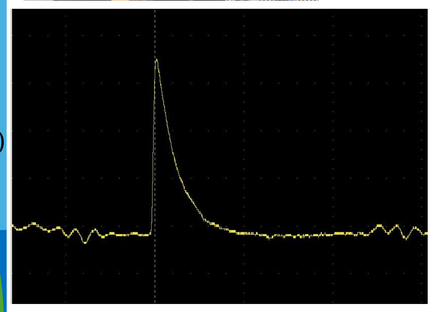
$$\mu^{\pm} = e^{\pm} + \overline{\nu_e}(\nu_e) + \nu_\mu(\overline{\nu_\mu})$$

TeachSpin™

TeachSpin is a company dedicated to manufacturing and distributing devices and equipment to make it easy for any institution to teach modern physics experiments and concepts.

Using TeachSpin's "Muon Physics" devices, the number of muons counted by a detector was recorded from March 22, 2024, to April 12, 2024.

This data was recorded and analyzed using various equipment and programs.

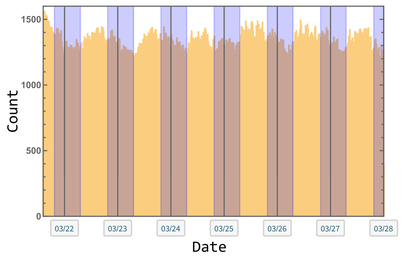


Detected muon waveform using an MSO64 Oscilloscope

The "Muon.exe" program used to obtain a muon count rate

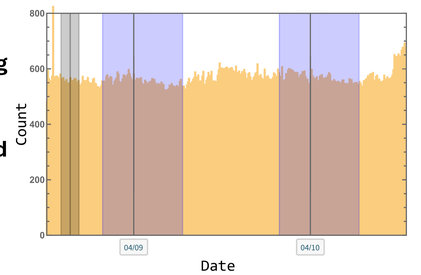
Data and Graphs

Average Day-Night Cycle



From data taken over the course of several days a trend in muon counts can be seen that match the day night-cycle.

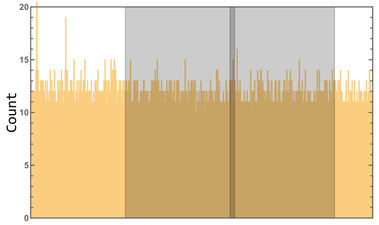
Eclipse Muon Flux



Muon count was recorded during the eclipse (highlighted in gray).

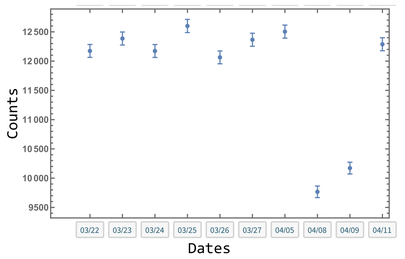
No dramatic trend was recorded in muon count rate.

Eclipse Muon Flux



When zoomed in on the time of the eclipse, there is no noticeable trend can be seen.

Integrated Counts During Eclipse Time Of Day



The total number of counts during the hours of the eclipse were taken for all days and compared.

Results

From the data we were able to confirm that there was a measurable fraction of muons that originate from the sun but were unable to find conclusive evidence that indicates a decrease in count rate caused by the eclipse.