Analysis of the Atmospheric Muon Flux Utilizing CosmicWatch Muon Detectors

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Earth is subject to continuous irradiation by particles from space, known as cosmic rays. When cosmic rays interact with atmospheric molecules, some decay into muons that approach Earth's surface at near-lightspeed. The origin of the most energetic cosmic rays remains unknown, which constitutes one of the paramount unanswered questions in astrophysics. Following construction of a CosmicWatch Muon Detector, a 24-hour measurement was conducted. Reconfiguration of the detector units allowed for measurements with zenithal angles 0° and 90°, and solid angles between 1 sr and 6 sr. Data was collected during a flight and beneath solid steel, allowing flux modeling at different altitudes and through steel. Data analysis utilized poisson statistics and p-tests. The 24-hour measurement showed a constant mean detection rate of 0.19 Hz. Detection frequency increased linearly with solid angle, and varying the zenithal angle from 0° to 90° resulted in a 80% flux reduction (40 standard deviations). Data showed a flux increase by altitude, with a frequency of 4.7 Hz at altitudes around 11600 meters. The study shows that one meter solid steel is sufficient to decrease muon flux by 50%. This study showed no significant difference between daytime and nighttime muon fluxes, indicating that solar energetic particles lack sufficient energy to produce sea-level reaching muons. A model of the atmospheric muon energy was developed. Further research will model correlations between muon and cosmic ray energies.

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