Cosmic ray effects due to meteor shower using high altitude balloon experiment

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Abstract

In past, many studies are done on cosmic ray but no one has yet thought to study the effects when there is a meteor shower. Our article introduces a novel experiment conducted on the peak time of the meteor shower and explains the procedure of the experiment. Firstly, our experiment is detecting the possible effects of the cosmic ray due to a meteor shower using High altitude balloon. It also explains cost-efficient cosmic ray detectors used in the stratosphere- Particle detector with a combination of photomultiplier sensor or tube, plastic scintillator. The detectors use a tracking mechanism to track the meteor shower. Although, stratosphere conditions can be created in laboratories like Temperature, Pressure, humidity and even some radiations can be generated. The reason why one should opt for HAB for this experiment is primary cosmic rays are observed enormously in high altitudes than the ground.

Introduction

These are high-energy nuclei and protons moving throughout the space at the speed of light[Sha04]. and were first observed in 1912 by Victor Hess in a high-altitude balloon experiment. These are originated both from the sun and outside the solar system[Bas]. Due to the earth's atmosphere, the cosmic ray breaks into a shower of secondary particles. They provide us with a direct sample of outer space. Cosmic rays have energies higher than any man-made beams, the interest in studying photons and atomic nuclei at ultrahigh energy significantly increased [Sch86].

Detectors

With the advent of solid-state detectors, it is quite possible to construct a device with the high-mass resolution of cosmic ray isotopes composition. Sub particles direct detection is not possible; whereas, interactions can be seen with the detector. For example - strong interactions in hadronic showers and weak interactions at neutrino detection [DAm+04].The change in energy and direction is observed due to the interaction of charged particles(electromagnetic interactions with electrons and nuclei). These interactions result in particle scattering, bremsstrahlung, Cherenkov, the transition of radiation, ionization, and excitation of the atom. The energy loss is due to ionization and bremsstrahlung, and the change of the particle trajectory is because of collisions with nuclei [GB11].

Experiment procedure

AIM

To conduct the cosmic ray detection on day of meteor shower.

ELECTRONICS

The energy absorbed by the detector is converted directly or indirectly to the signal. For example, the scintillator is shown as an example of indirect conversion.

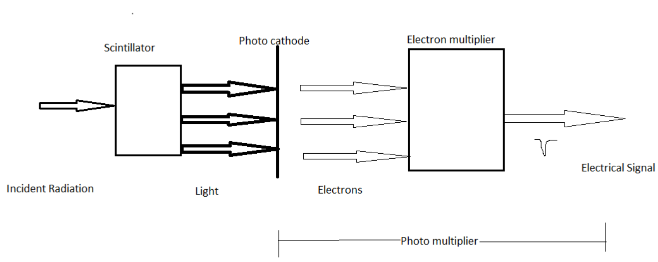

Figure 1: Scintillator detector

The charged particle is observed in the scintillator and converted into visible or near-visible light. When photons strike on the photocathode, producing a photoelectron. It is directly detected or sent through a gain mechanism. The pulse shape in the scintillator detector is determined by the decay times of the optical state. The non-radiative energy transfer is involved before the optical state is populated and decayed.The overall pulse shape has a rise and a decay time with the approximate form:

$$I(t) = I_o(e^{-t/td} - e^{-t/tr}) \tag{1}$$

where tr and td are the rise and decay time constants respectively. The charge-sensitive amplifier with high input resistance. When amplifier inverts produces the voltage gain of

$$dv_o/dv_i = -A. \tag{2}$$

The feedback capacitor c is connected from output to input. If the input voltage is vi, corresponding the output voltage is A*vi is produced at the amplifier output.

CIRCUIT

The detector requires an understanding of the detector physics as well as the characteristics of read-out electronics. [Gru+08] A typical particle detector consists of the following electronic

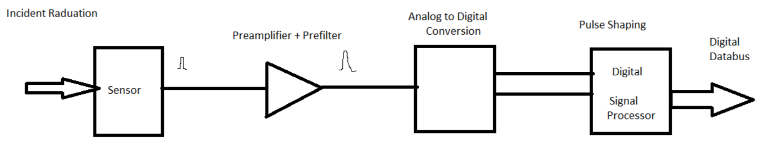

Figure 2: Circuit Diagram

components: charge sensitive amplifier, a pulse shaper, and a digitizer is used for converting the signal and subsequent signal storage. With analog and digital circuitry, Pulse processing is performed. In addition to that, the sensor signal is pre-filtered in the pre-amplifier followed by digitization. Pulse processing is optimized to a signal-to-noise ratio.

PARTICLE IDENTIFICATION

With respective how the material is arranged and type of material, the detector/ calorimeters are usually sub-divided into electromagnetic and hadronic. The particles interacting electromagnetically (electrons and photons) are absorbed in the electromagnetic part, and particles interact strongly (like ±, p, n, K±) in the hadronic part.

The charge-track-point method is used to distinguish the sub-particles. In the comparison of measured energy to previously measured momentum of the particle (E/p). If E/(cp) is approximately equal to one, a (relativistic) electron originated the signal, for hadrons one has E/(cp) is less than one (deposition of only a part of the total energy), and muons produce an energy deposit compatible with minimum ionization only.[Kle99]

Expected Results

Cosmic rays are not absorbed by stars, planets, meteorites, and dust because these particles' transverse size is below the interaction path. It is expected to give a few additional contributions to the fragmentation and production of albedo secondary cosmic rays. Let's assume the body of interest is of type x with the area of cross-section S.

$$S = 4 * \pi * {r_x}^2 \tag{3}$$

Spatially distributed with concentration N with average distance d.

$$N = {d_x}^{-3} \tag{4}$$

The mean lifetime of a Cosmic ray particle with velocity V relative to absorption of the meteoroid is [Dor06]

$$\sum_{n=x} (S_x * N_x * V)^{-1} = \sum_{n=x} ({d_x}^3 / 4 * \pi * {r_x}^2) \tag{5}$$

Conclusion

This experiment has not been conducted yet. It will be conducted on Geminids Meteor Shower 2021. The Primary cosmic rays consist mainly of protons, particles, and a few heavy nuclei (lesser than or equal to 3). It is interacted by the atomic nuclei of the meteor shower and atmosphere. In this way, predominantly pions and kaons are produced. These mesons can either induce further interactions or decay. (Pions and kaons are mesons that belong to the group of strongly interacting particles include baryons and mesons. Protons, neutrons, and their excitations are baryons and different energy loss is expected.

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