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A Comparative Study of Cosmic Rays

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Abstract: Energetic particles, traditionally called Cosmic Rays, were discovered nearly hundred years ago, and their origin is still uncertain. The extraordinary energetic cosmic ray particles originate from outside our own galaxy. Cosmic rays are absolutely protons and nuclei that barrel through latitudes and almost equal to the speed of light. First discovered in 1912, the true range of their energies was only realised in the 1960s when some cosmic rays were discovered to have very high energies. Few years ago the particles are a mixture of protons and heavier nuclei. Since nuclei are charged particles.

Keywords: cosmic rays, proton, elementary particles, cosmic ray shower.

I. INTRODUCTION

In 19th century German Scientist Hess performed an experiment in which he found that the rate of leakage of charge at the height of earth surface increases. After doing so many experiments by the different scientist they finally conclude that the unknown radiations coming out from the atmosphere reaching on the earth surface. These unknown radiations are called cosmic rays. These rays are more powerful than all the radiations. Cosmic rays are high-energy radiation, primarily originating outside the Solar System. Cosmic rays can create showers of secondary particles that typically reach the surface.

II. COMPOSITION

99% are the nuclei of well known atoms which originate from outside the Earth's atmosphere are of primary cosmic rays and about 1% is solitary electrons (similar to beta particles). About 90% are simple protons of the nuclei (i.e., hydrogen nuclei); 9% are alpha particles, identical to helium nuclei; and 1% is the nuclei of heavier elements.

A. Types Of Cosmic Rays

- 1) **Primary Cosmic Rays:** Primary cosmic rays basically generate from outside the galaxy and sometimes even the Milky Way, they are converted to secondary particles when they collide with Earth's atmosphere. Cosmic rays made up of charged nuclei heavier than helium are called high energy ions., their contribution to an astronaut's radiation dose in space is significant due to the high charge and heavy nature of high energy ions even though they are relatively scarce. They are mainly consists of high energetic protons. In addition to protons other nuclei, like electrons are also present in small quantity. The energy range of the constituent particles lie in between 3 BeV to 30 BeV.
- 2) **Secondary Cosmic Rays:** In the Earth's atmosphere when cosmic rays enter, they interact with atoms and molecules, mainly oxygen and nitrogen. The interaction generates a cataract of lighter particles, so called air shower secondary radiation that rains down, including x-rays, muons, protons, alpha particles, pions, electrons, and neutrons. Typical particles generate in such intraction are neutrons and charged mesons such as positive or negative pions and kaons. By using so many particle detectors like, cloud chamber, bubble chamber or scintillation detector the muons can be easily detected. Upto the height about 20 km from the sea level all cosmic rays are secondary in nature. Their penetration power is very large but due to the absorption of cosmic rays particles its intensity decreases with distance.

III. SOFT AND HARD COMPONENTS OF COSMIC RAYS

At the height of 3.5 km above the sea level a lead plate of 12 cm thickness absorbs about 50% of total cosmic particles. Thus their penetration power is very small.

Hence these cosmic particles are called soft component. Mainly electrons, positrons and photons are there. And the rest 50% whose penetration power is quite high are called hard components of the cosmic rays. Mainly muons are there. The ratio of the soft and hard component is different at different height. Total cosmic radiation at sea level is made up of (¼) soft component and (3/4) hard component of cosmic rays.

Milikan studied the intensity of cosmic rays at the different places. His observations suggested that the intensity was constant at the all latitude.

A. Altitude Effect

The intensity of cosmic rays is different at different heights from sea level. The intensity first increases to maximum and then decreases exponentially. The reason is that when the primary cosmic rays fall at the top of the atmosphere, they generate secondary rays. These rays also have the ionized particles. As a result intensity increases. But at some position where generation of secondary rays stop, at that position increase in intensity also stops afterwards intensity of cosmic rays decreases exponentially. At high altitude the peak shows that the primary cosmic rays are 1/5th of the secondary cosmic rays. About 2x10¹⁸ cosmic particles are falling per sec on the atmosphere.

B. Latitude Effect

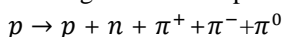
The intensity of cosmic rays is greater at higher latitudes in comparison of lower latitudes of earth. At magnetic equator $\theta=0$ the cosmic ray intensity is minimum. At $\theta=50^{\circ}$ N to $\theta=90^{\circ}$ N and $\theta=50^{\circ}$ S to $\theta=90^{\circ}$ S the intensity of cosmic rays is almost constant. From latitude 49^o to 0^o the cosmic ray intensity decreases exponentially.

C. East-West Asymmetry

At certain height and latitude the intensity of cosmic rays coming from west direction is greater than that of east direction. So the excess particles reaching from west in comparison to east, it is possible when cosmic rays should have more charged particles, Asymmetry decreases at zenith angles more than 60^o. It is maximum at equator and less at height. And it increases as the height increases from the sea level. Cosmic rays consists of mostly protons.

D. Cosmic Air Shower

A very large number of elementary particles and photons are produced by the decay and interactions of particles produced by the primary cosmic particles. Many times a single particle can produce a very large number of secondary particles. This shower of secondary particles is called the cosmic air shower. When highly energetic protons interact with oxygen and nitrogen then they disintegrate into fast protons, a neutrons, charged as well as neutral pions.



Each photon produces electron –positron pair again and so on till the energy falls below a certain value. In this way single neutral pion produces a shower of electron, positron, pions, mesons, then this is called cascade shower. if highly energetic particle enters the atmosphere of earth, then it produces a very large number of secondary particles and the shower of these particles would cover a large area. This type of shower is called Auger shower

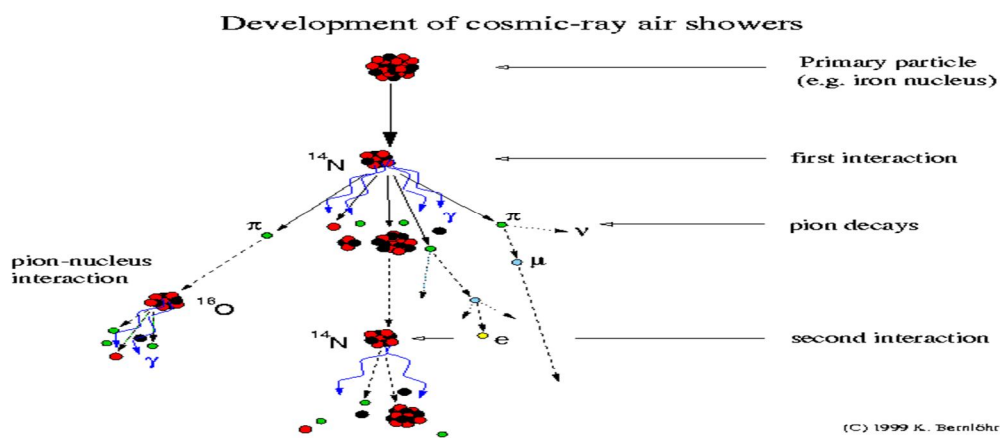


Figure of Cosmic air shower

- 1) *Advantages of Cosmic Ray:* Cheaper and better than X-rays
- 2) *Disadvantages of Cosmic Rays:* It has limited detection ability, can't detect small nodes or deeper structures. It is damage our DNA and causes cancer. As a driver of evolution. radiation can cause genetic defects which will probably be useful. As a autoclave. probably harmful organisms that drift through area are unlikely to survive cosmic irradiation.



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