Detecting Cosmic Rays

■Purpose of Exhibition

Electrons and nuclei shower onto the earth from every direction of outer space. They are a kind of radioactivity called cosmic rays. Let’s have a look at an exhibit that shows evidence of their movement. Pale blue traces shining in the box are areas where cosmic rays passed. If you watch it for a while, you will notice many cosmic rays pass through it. Like this box, cosmic rays also pass through your body.

■Additional Knowledge

-Cosmic Rays generate secondary cosmic rays in the upper atmosphere-
The cosmic rays from the space themselves (primary cosmic rays) do not penetrate your body. Secondary cosmic rays produced by collision of primary cosmic rays with the air in the upper atmosphere descend to the earth's surface. Cosmic rays that have reached the earth at almost the speed of light collide with the air and produce a nuclear reaction, Neutrons and protons are coming from a nuclei of the air (nitrogen and oxygen etc.) accompanied by the generation of particles such as muons.

-Ability to reach the earth's surface due to the relativistic effect-
The lifespan of a muon is approximately one 500-thousandth of a second. Within such a short lifespan, muons are able to travel no more than 600 meters, even at the speed of light and thus expire before reaching the earth’s surface from the upper atmosphere, with the result that they would not reach the surface. However, since cosmic rays travel at almost the speed of light, the resulting relativistic effect prolongs the lifespan of muons, enabling them to travel long distances and reach the earth’s surface.

-Mechanism that makes it possible to see cosmic rays-
Cosmic rays cannot be seen with the naked eye. So, let’s take a look at how this exhibit works.

- Spark Chamber
The tall device in the back of the photograph is a spark chamber. Inside this device, a box filled with helium contains metal plates arranged in equidistant alignment. When a cosmic ray passes through this box, the helium on the trajectory along which the ray travels becomes ionized. Applying high voltage to the metal plates at that moment generates an electrical discharge through the ionized helium, producing a bluish white light that can be seen with the naked eye. In other words, applying high voltage at the exact moment when cosmic rays are detected makes cosmic rays visible to the naked eye. Radioactivity (cosmic rays) detectors called "scintillation" counter are mounted in the device above and below the box. The device is designed so that high voltage is applied only when a cosmic ray passes through these two detectors or, in other words, when a cosmic ray travels on a vertical trajectory. This is because it would be difficult to observe cosmic rays traveling on diverse trajectories. In fact, approximately two cosmic rays pass through an area of the earth's surface of 10 square centimeters every second. Note that a synthetic sound is produced whenever a cosmic ray is detected to let us know that a cosmic ray is passing through the device.

- Cloud Chamber
The device in front of the photograph is a cloud chamber. This device contains alcohol vapor. The interior of the device features a steep temperature gradient with a high upper setting and a low bottom setting to maintain the unstable supersaturated environment immediately before the vapor becomes a liquid. When a cosmic ray passes through the box, it produces an ion trail, along which the alcohol vapor collects together to be condensed to liquid. It looks like a cloud. The ion formation differs depending on the type of particle, making it possible not only to detect the passage of cosmic rays, but also identify their types.

- Where do cosmic rays originate?
Cosmic rays may originate from solar flares (explosive energy emissions from our sun) or supernova explosions outside our solar system. In addition, while cosmic rays
are made up mostly of protons, they are also elements such as alpha particles and even heavier atomic nuclei.

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