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Cosmic rays are energetic particles that originate from interstellar space that hit our atmosphere at high velocity 30km above the Earth's surface.

These particles stream through the universe and come from distant catastrophic events like exploding supernova, colliding stars, black holes and yet unknown happenings in the outer most reaches of space and time.

These same processes also made many of the heavier elements that now form planets and even the building blocks of life over billions of years.

Cosmic Rays showered down across the entire surface of Earth and have been present throughout the entire evolutionary history of life on our planet. Cosmic Rays are an everyday reminder, of the immense scale, age and complexity of the universe.

A reminder our tiny planet is floating in a quiet point in time and space, a place where everyone we know and will ever know will live out their lives.

A rare fragile and precious place something worth protecting.



Energetic particles

Although commonly called **cosmic rays** the term "ray" is a misnomer, as cosmic particles arrive individually as a primary particle, not as a ray or beams of particles. 90% are Protons, 9% helium nuclei, and the remainder electrons or other sub-atomic remnants.

Matter smashing energy

When these primary particles hit, they do so with such tremendous energy they rip their way into our atmosphere with atom smashing power. Cosmic rays are commonly known to have energies well over 10^{20} eV (electron volts), far more than any particle accelerator built here on earth, like the Large Hadron Collider.

These interactions produce an exotic zoo of high energy particles and anti-matter particles, high in the earth's atmosphere such as positive and negative pions and kaons that subsequently decay into muons and muon-neutrinos. Pions that decay to become the starting points of large cascades of electrons, positrons and gamma rays. The resulting flux of particles at ground level consists mainly of muons and electrons/positrons in the ratio of roughly 75:25% still with energies greater than 4GeV travelling at near the speed of light $\sim 0.998c$.

Natural interstellar events on earth

Muons created by the interaction of cosmic rays and our atmosphere lose their energy gradually. Muons start with high energies and therefore have the capacity to ionise many atoms before their energy is exhausted. However, as muons have little mass and travel at nearly the speed of light, they do not interact efficiently with other matter. This means they can travel through substantial distance of matter before being stopped. Consequently, muons are raining down about us, passing through just about everything. They can penetrate mountains, buildings, our bodies, and deep into the Earth's surface, without anyone really being aware of their existence.

Time Travellers

Muons created by the interaction of cosmic rays are an everyday demonstration of Einstein's theory of relativity. A muon has a measured mean lifetime of ≈ 2.2 microseconds. Consequently, they should only be able to travel a distance of 660 metres even at near the speed of light and so should not be capable of reaching the ground. However Einstein's theory of relativity tells us that time ticks slowly when moving at speeds close to that of light. Whilst the mean lifetime of the muon at rest is only a few microseconds, when it moves at near the speed of light its lifetime is increased by a factor of ten or more giving them plenty of time to reach the ground.