

Summer Project'25

Astral Trails

SUMMARY OF SESSION 4

COSMIC RAYS: Top Ten Questions about what you have learned

Catch a Cosmic Ray Program



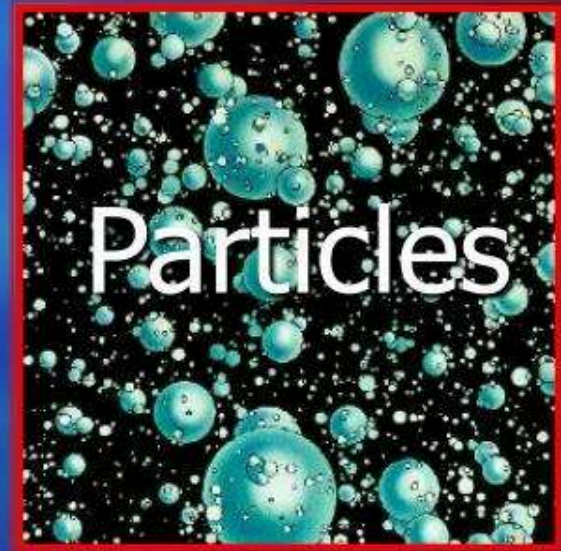
MICHIGAN STATE
UNIVERSITY

1. Cosmic rays are:

- What kind of radiation?



or

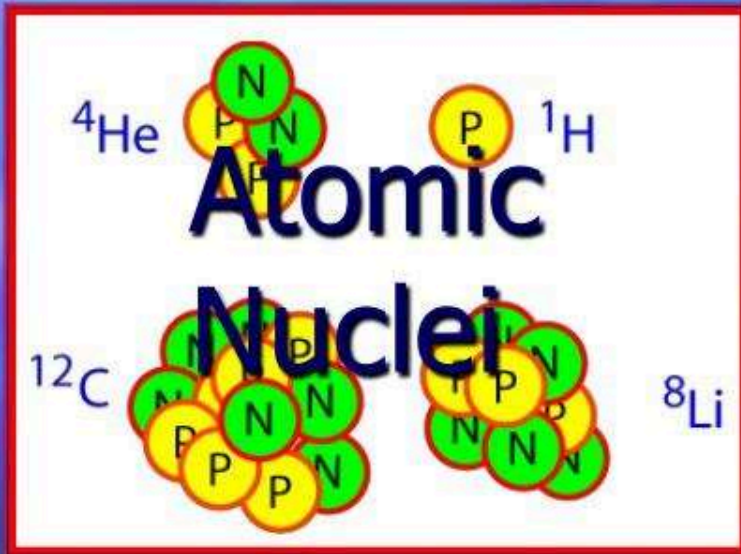


Even though they are called “rays”, cosmic rays are tiny **particles** traveling through the air

You can't see them, but a radiation detector like a Geiger counter or **CRD picks them up**

2. Cosmic rays are:

- What kind of particles?



or

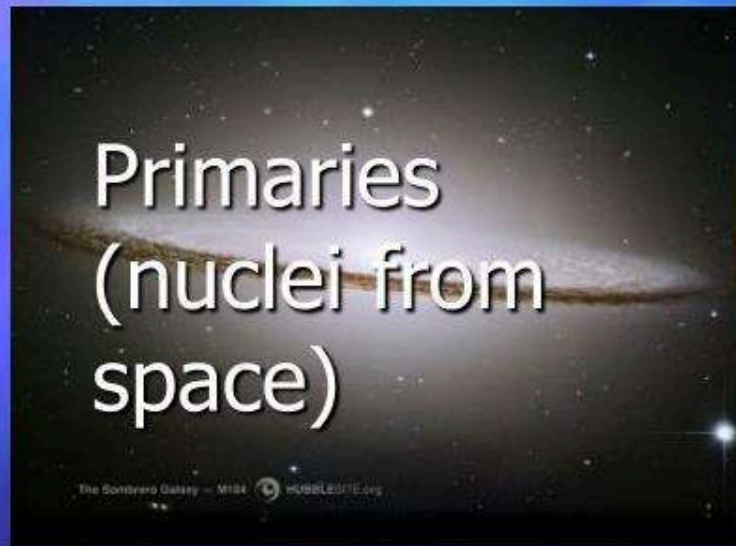


It took a long time for people to realize that the "cosmic rays" were the same as the **nuclei** found in every atom. They are *way* too small to see, even with the most powerful microscope.

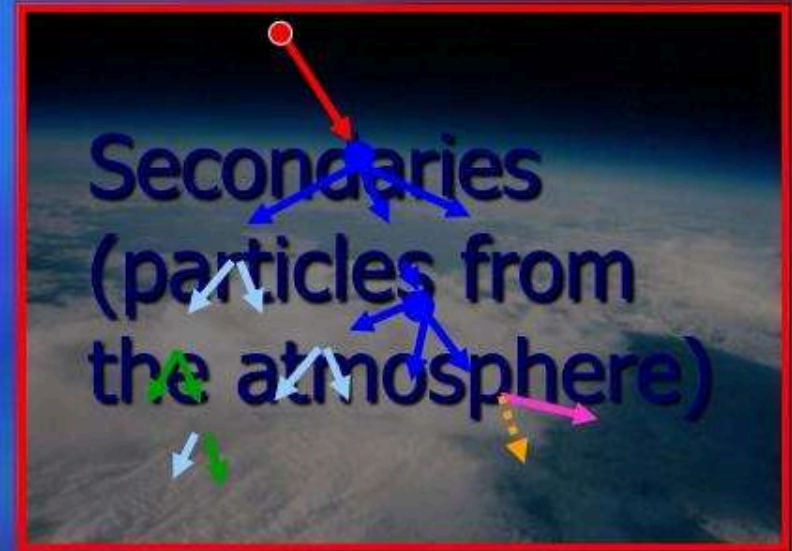
3. Cosmic rays are:



- Come in two kinds. Which do we see at ground level?



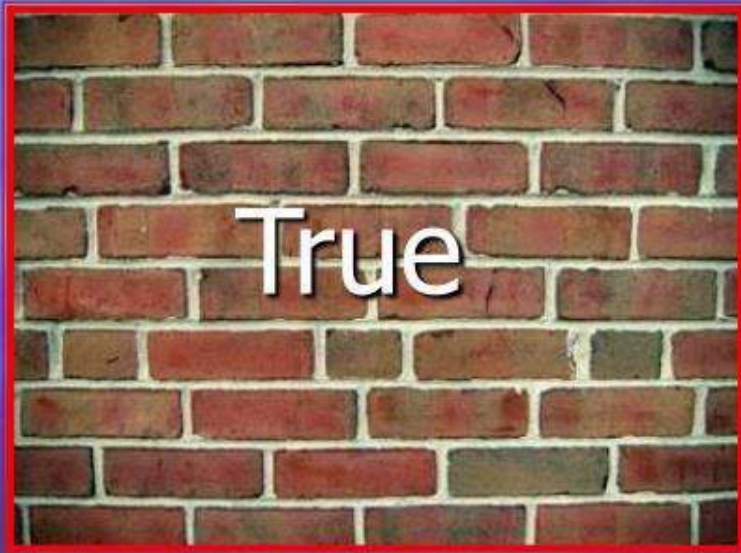
or



- **"Primary"** cosmic rays are the **interstellar nuclei** coming from an extraterrestrial source (solar wind, supernova).
- **"Secondary"** cosmic ray showers are caused when the primary knocks **particles in our atmosphere** downward, which we can detect with CRDs at ground level.

4. Cosmic rays are:

- Can be partially blocked by matter (walls, air, people, etc.)



or



Because cosmic rays are nuclei, their protons can **interact** with other charged particles in matter, causing them to **deflect or rebound**. The more matter in the way, the fewer cosmic rays get through.

5. Cosmic rays are

- More common at higher altitudes because:



or



Victor Hess took his cosmic ray detector up to 5000 meters in a balloon, finding **more rays at higher altitudes** and thus proving that they are originally coming from **space**

6. Cosmic rays are:

- Mostly coming from what direction?



or



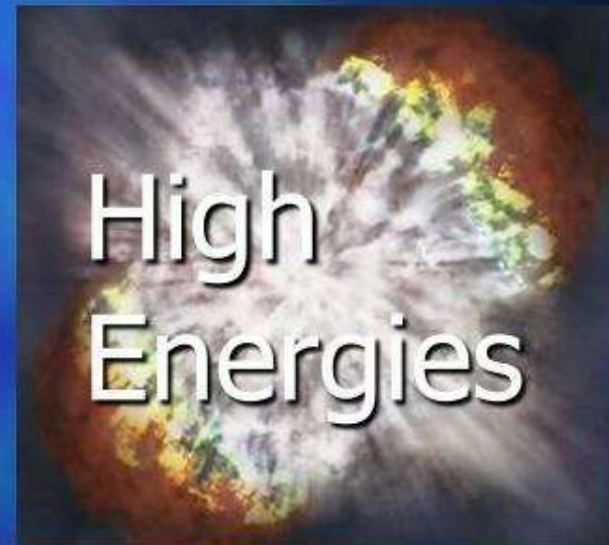
Coming from straight **overhead**, cosmic rays are **traveling through less atmosphere**, which means they are absorbed/scattered less.

7. Cosmic rays:

- Typically have how much energy?



or



Trillions of **low-energy** cosmic rays are hitting earth right now, while only about 40 ultra-high-energy cosmic rays (UHECRs, $>10^{18}$ eV) have ever been detected

8. High-energy cosmic rays

- Are easiest to detect with:



or



Detecting a cosmic ray is all about the **size** of your detector... you need to cover the largest area possible, especially to catch the rare UHECRs! **Ground detectors** are cheap and simple to build over **large areas**.

9. Cosmic rays are:

- *Mostly* produced by what likely source?



Stars

or



Black Holes

While UHECRs may be produced by black holes, the vast **majority of cosmic rays are "low-energy"** nuclei in the solar wind produced by stars. "Medium-energy" CRs are probably launched by exploding stars (supernovae).


10. High-energy cosmic rays:

- Can be used to:



Measure the
brightness
of distant
objects

or



Trace back
to the
source they
came from

The **galactic magnetic field** causes CRs (which are charged nuclei) to **turn**, so when they reach Earth they're coming from a different direction. But **UHECRs travel straight**, so they're valuable because you can see where they're from!