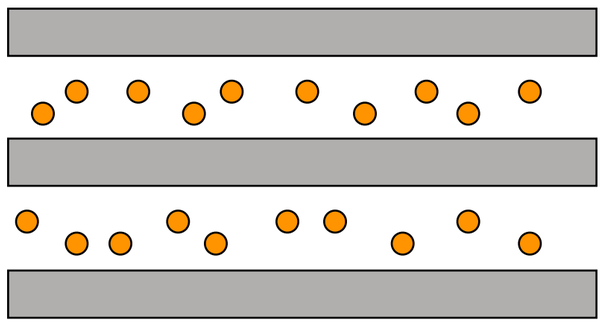
WHY DOES IT SPARK?



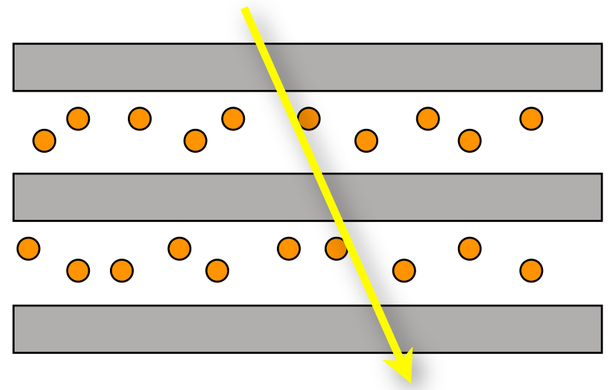
The spark chamber is made up of metal plates, and a mixture of helium gas filling the space inside.

In its initial state, the gas in the chamber is made up of atoms that are electrically neutral.

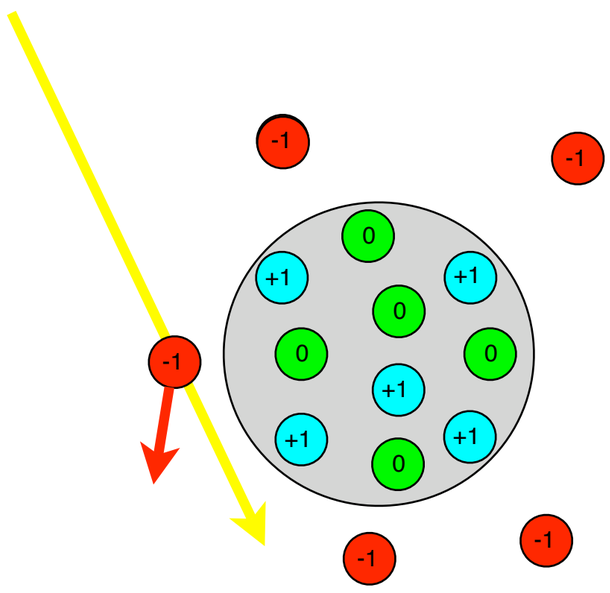
Note: ● represents a gas atom

A cosmic ray enters Earth's atmosphere.

Traveling through the relatively dense atmosphere causes the cosmic ray to interact with molecules in the atmosphere, creating various particles. The particles includingone that is similar to an electron, but 200 times as heavy, called a muon. Refer to the cosmic ray poster.



Muons are the most abundant electrically charged remnant of the ray that reaches the ground, and are also easily detectable.
One is shown here as a yellow arrow, passing through the detector.



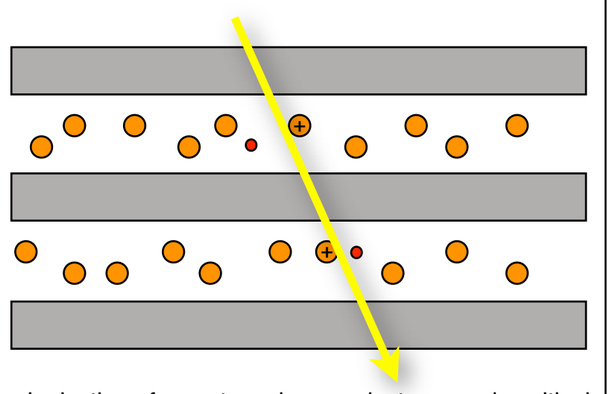
● is a neutron with zero charge
● is a proton with positive charge
● is an electron with negative charge
→ is the muon (cosmic ray remnant)

To the left is an atomic view (not to scale) of what happens as the muon particle travels through the chamber.

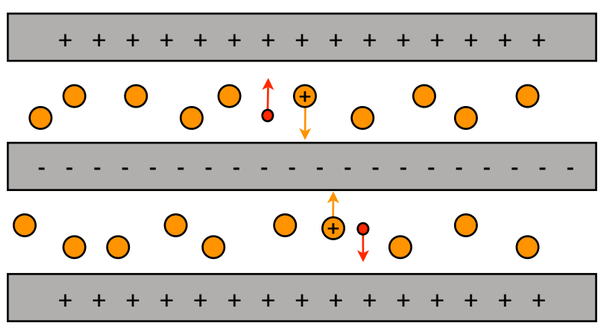
As the muon travels through the chamber, it knocks electrons (●) off their orbit around the nucleus. The nucleus itself does not lose particles because it is densely packed, and the energy required to break its bonds is far higher than the energy required to knock an electron off its orbit around the nucleus.

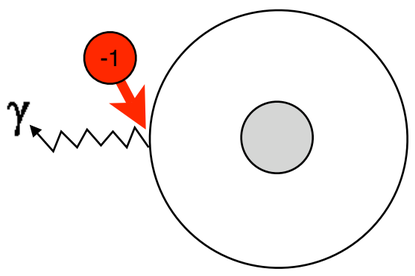
The atoms in the gas are originally neutral. Since electrons have a negative charge, when they are knocked off the atom, it leaves the atom with a net positive charge. Due to having a net charge, the atom is now called an ion.

As the muon goes through the chamber, it knocks electrons off numerous atoms. Therefore, a trail of ions and free electrons are left along the muon's path. The path is called ionized
A picture of this can be seen to the right.



Ionization of gas atoms leaves electrons and positively charged ions along the path of the muon





After the muon passes through the spark chamber, a large potential difference is applied to the plates by oppositely charging the plates as seen in the diagram above. This arrangement creates an electric field in the space between the plates. Charged particles are pushed by the electric field much like an object falling off a table is pushed through Earth's gravitational field.

However, since there are two types of charge, the free electrons and the positive ions will be pushed in opposite directions depending on the sign of their charge. The free electrons are attracted toward the positively charged plates, while the positive atoms are attracted to the negatively charged plates, shown in the figure on the above left. As the electrons fall, they speed up and gain enough energy so that when they encounter another atom, it knocks an electron off, creating another electron and ion pair. This continues to happen, creating an avalanche of free electrons and ions.

Along this path, a discharge occurs, forming visible light. Examples of processes that create visible light are electrons "recombining" with ions (see picture on above right) and excited electrons that drop to orbits closer to the nucleus.

Through the spark chamber, the travel of a particle that is invisible to us in daily life is rendered visible.