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ATRIA

Project Proposal

PRESENTED TO:
CERN

PRESENTED BY:
Team Atria

Motivation

Experimental sciences have always been a parallel support to physics. Adhering to the life of elementary particles opens a new way. One such particle is **Muons** which is mysterious and unstable.

Muons travel at around 99% of c which makes them inherit a special relativity property:-

- Time Dilation
- Length Contraction

Atmospheric muons travel almost 15 km defying their life span. This phenomenon is called “The Muon Paradox”. But experiments have proved that only a few muons reach the earth’s surface, others decay on the way to the surface of the earth to deep underground and underwater ionizing radiation.

The members of Team Atria were very curious about these few muons' properties as we know that under the influence of magnetic field muons wobble and decay. Our earth is a magnet thus providing muons with a magnetic field to interact.

But this didn’t satisfy our curious minds, we also wanted to compare the properties of “normal” muons which wobble and decay under magnetic field.

Project

Why are muons so special? When the G-2 experiment took place we were evenly curious about the result but still, we are not sure about it. Team Atria discussed for weeks and came with a hypothesis; **Two sides of Muons**. This hypothesis talks about special relativity and quantum mechanics or in short quantum electrodynamics.

The team was interested in knowing the properties of **"Special muons"** and **"Normal muons"** under Magnetic fields. **Special muons are the surviving muons under time dilation which were formed in the atmosphere of Earth because of cosmic rays. And normal muons are the decay of pions and kaons of the negative particle beam.**

Team asked some amazing questions; what is so special in "special muons"? Why do they survive? What is the energy difference? What is the trajectory difference and why do they survive till end and decay? Does this mean that we are lacking something in standard model explanation?

These questions made the team real curious and investigative. Due to the detail-oriented efforts of the team we then came with our experiment; two sides of muons.

Detectors and their needs in the experiment:

- **Scintillators (Scintillation Counter)**

A scintillator is a material that emits scintillation light when penetrated by ionized radiation. This material will be struck by a charged muon in our experiment, and it will absorb some of the muon energy and scintillate i.e. Re-emit the absorbed energy in the form of light. A scintillation counter will be obtained when we connect a scintillator slab to an electronic light sensor, a device that converts light into an electronic signal in a photomultiplier tube. Photomultiplier tubes absorb the light emitted by the scintillator and re-emit it in the form of electrons via the photoelectric effect. The subsequent multiplication of these photoelectrons results in an amplified, electrical pulse that can be analyzed; yielding meaningful information about the muons that struck the scintillator. We are using this detector to check and count no. of muons interacting in the magnetic field in our experiment.

- **Muons Filter**

A Muon Filter is like an absorber/reflector in which other particles like kaons, and pions cannot pass through it but muons can easily penetrate through it. Here in this experiment, the negative beam that we use will pass through it to obtain a selected beam of Muons and thereafter pass through a scintillation Counter and Delay Wire Chamber(DWC).

- **Delay Wire Chamber (DWC) / Tracker**

By using this 2D particle tracker, our team wants to know the trajectory, and position of the muons that are interacting with the magnetic field. We will compare the data of both normal muons and special muons(Difference in their trajectory, position). We will check if normal muons(muons obtained from a beam) wobble after coming in contact with the magnetic field. We will also use DWC to detect and study Atmospheric muons (Special muons of our Experiment.)

What is our Experiment?

Special muons are more mysterious than normal muons. The team proposes to place an muon detector and a muon filter which detects special muons and then to find its energy, trajectory, mass, decay and may be a new force.

Normal muons pass through a permanent magnet and then the obtained beam is passed through the same testing.

This gives a clear idea of the ratio of the energy and mass. If the result shows that special muons are different from normal muons we might get a new path of particle physics.

Experimental Setup:

In this experiment, we would like to place the scintillator detector, DWC tracker, permanent magnet, and muon beam in a single row such that we can measure the muons and their counts after interaction with the magnetic field. Here we are studying the characteristics of normal muons formed by the decay of particles of the beam given to us.

We would also like to place a muon filter with a detector at the initial beam entrance in the detector to obtain a muon beam.

Along with this we would like to measure the special muons that are formed by the collision of cosmic rays and earth's atmosphere and study the difference between normal muons and special ones.

This will prove that normal muons have different properties and special muons are new force carriers apart from ones in the standard model.

Take away from this experience:

From this experience, we hope to gain hands-on experience in research & creative projects. This opportunity could help us increase our passion and help us inspire and empower ourselves and many other students in our community.

This can also provide us with an early professional working experience in the fields of our passion allowing us to pursue our interests, to learn something new, to hone your problem-solving skills and to challenge yourself in new ways.

Working on a faculty-initiated research project gives us an opportunity to work closely with a mentor—a faculty member or other experienced researcher. Assisting and going further in depth in this research can give us hands-on experience which is extremely exceptional at such a young age.

This is also an opportunity to hone our leadership and teamwork skills as we collaborate with each other to discover new knowledge and expand about what we already know.