Description

Introduction to Viewing the Unseen

Standards

1.3 - 1.5

2.1 – 2.4

5.1, 5.2

5.3g

Learning Objectives

Students will be able to explain how phenomena that can’t be seen can be quantitatively measured.

Student will be able to verify the existence of ***fun***damental particles (muons).

Prior Knowledge

Examples for comparison:

1. TV remote control uses IR waves to send signal to device🡪 there are particles that exist that we can’t see with our eyes, but they are there and they are measurable.
2. Dog whistle, bat sonar, elephant infrasonic communication

Background Material

Energy conversions

Electrostatics and electrodynamics

Waves and light

Photoelectric effect

Implementation

Day 1 -

Stations:

1. Use cell phone camera to show visual example of IR signal.
2. Connect photocell to speaker, aim IR waves at photocell to show proof that the signal is there, and can be converted to an audible signal.
3. Scintillator with UV light
4. Air cannon
5. Cloud chamber?
6. Geiger counter (maybe???)

Stack 2 counters. Radiation source is on top of counters. Observe results and view rate graphs. Switch radiation source to other counter. Observe again. Explain that the counters contain scintillator material like they saw in the station lab. Ask what the scintillator did when it was hit with UV light.

PMT – Like a flashlight in reverse (voltage results in light, light results in voltage), photoelectric effect

Explain that each counter hit is represented by the blue blinking light. What can be inferred by both counters being lit at essentially the same time?

Explain that if both counters observe an event within a small time window, we have “coincidence” and that triggers the number to advance by one. (The two possibilities here are that they either both observed a high speed particle, or they coincidentally happened to fire at the same time.)

Pose question: What will happen if the radiation source is removed?

Pause for shock and awe…

Why is there still a count? What could be causing the lights to still blink?

Slowly move counters from stacked setup to array, and observe the trigger rate on DAQ decrease or even stop.

What did you observe in the cloud chamber? (i.e. There are multiple “windows” to the unseen.)

Next have student hold counter vertical. What does the graph show about direction of radiation source?

If a LOT of lead shielding is available, test if the radiation is coming from above or below.

Homework -

Video clip of Hess’s experiment?

<http://www.fordham.edu/images/whats_new/magazine/fall11/cosmicconnections.pdf>

Day 2 –

<http://www.youtube.com/watch?v=dmyGzaB8DFo>

Discuss what we are seeing with the CRD.

Videos/readings/simulations (Super nova, shower simulation, muon lifetime study)

Experiment: What will happen to trigger rate as paddle overlap is increased?

Collect data for arrayed, ¼ overlapped, ½ overlapped, ¾ overlapped, overlapped.

Calculate flux at earth’s surface.

What other cosmic ray investigations could you do with this equipment? (Give a SHORT description of one of them.) Invite Juniors to pursue this next year. (Independent study???)

Connect to CERN (Detectors are essentially multiple variations of the CRD counters), neutrino detectors, and the Standard Model.

Assessment

Station lab questions, article questions, overlap lab