American Nuclear Society

Cloud Chamber

Introduction

Radioactive elements continually undergo a process of radioactive decay during which their nuclei emit high-speed particles and rays. These are much too small to be seen under a microscope. The Cloud Chamber is an instrument designed for the study of the trails of these radioactive emissions. The investigation is accomplished in the following way. First, the air must be saturated with water or alcohol vapor. When the high-energy particles plow through the air, electrons are knocked loose from some of the atoms and form ions. Ions act as excellent centers for condensation. This condensation, however, must be stimulated by cooling the air. The water vapor or alcohol condenses on the ions, leaving a vapor tail which clearly reveals the path of the ray.

Cloud chambers detect the paths taken by ionizing radiation. Much like the vapor trail of a jet airplane, the tracks in a cloud chamber mark where ionizing radiation has been traveling. The radiation itself is not visible. Radioactive materials are one source of ionizing radiation. The easiest tracks to see are made by alpha radiation. When first formed they are nearly straight lines, 1 to 5 cm long, but they quickly drift, become crooked and evaporate (or condense on the bottom of the can).

Materials

- Plastic cloud chamber kit, 3 1/4" diameter
- (Petrie dish with band of black construction paper around the sides and bottom painted black or lined with black construction paper)
- Alcohol - 95% ethyl
- Dry Ice
- Source - uranium ore, lantern mantle, Fiestaware piece
- Lamp - flashlight
- Magnet - optional
- Photographic film, unexposed roll

Instructions - Time: 30 minutes

Part 1 - Observing radioactive decay

Pre-lab activity

Several days before the investigation, place a tightly-bound, unexposed roll of photographic film in a drawer next to the uranium ore sample (uraninite) from the kit. It should be left there for at least 24 hours. Then, have the film developed and begin the discussion on the day of the investigation with an examination of the film.

Lab

Discuss the partial exposure which resulted on the roll of photographic film. The students should speculate on how this phenomenon occurred. From the basis of the results of this experiment, begin the investigation with the Cloud Chamber.

Provide the students with the Cloud Chamber Kit and the background information provided in the Introduction. Three types of rays are given off by a radioactive element. They are alpha particles (positive nuclei of helium atoms traveling at high speed), beta particles (high-speed, negative electrons), and gamma rays (electromagnetic waves similar to X-rays).

- Saturate the felt band on the inside of the Cloud Chamber with alcohol.
- Quickly place the radioactive source (uranium ore) on the bottom of the chamber and cover the entire chamber.
- Place a slab of dry ice in a tinfoil or paper dish and then set the Cloud Chamber on its surface. Wait until the air becomes saturated.
- Viewing will be much better if the lights are turned off and each student is provided with a flashlight. The lamp should be directed from above down onto the black surface of the Cloud Chamber.
- Observe the tracks of the particles and answer the following questions:

1. Where do the tracks seem to be coming from?
2. Do all the tracks have the same length?
3. Make a careful (accurate) sketch of the overall pattern of the tracks.

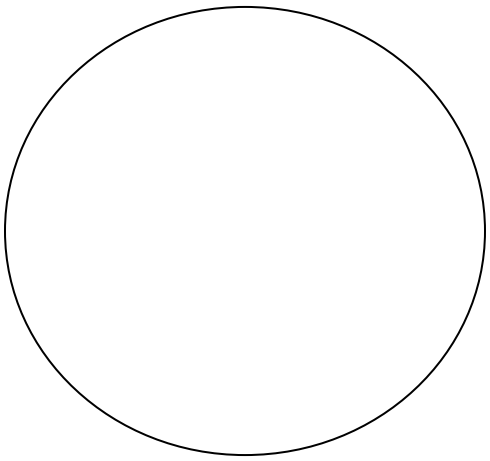

Figure 1: Diagram of Tracks in Cloud Chambers

4. Why are the tracks visible only near the bottom of the chamber?
5. What is it that your eyes actually see? Are the tracks actually radiation? Is a single alpha particle by itself visible?