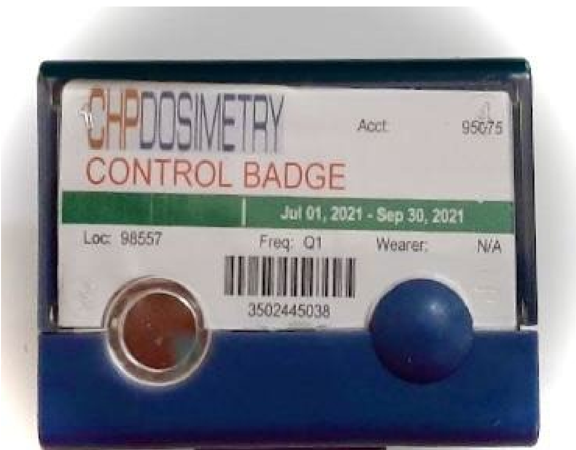
Thermoluminescent Dosimeter Balloon Test - Radiation



Prepared By

Catherine Manley and Sachita Upadhya

Janet Ivey-Duensing

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Introduction

The atmosphere is crucial to sustaining life on Earth. It protects us from radiation emitted by the sun and space. When reaching higher elevations, the amount of atmosphere and distance between you and space changes. This results in receiving higher doses of radiation than would be received at sea level.

This experiment was conducted in order to measure the amount of radiation when in high elevations. It helps us test the amount of radiation that is blocked by the atmosphere, which in turn ensures that the atmosphere is effective against the radiation that hits the Earth.

Our hypothesis before conducting this experiment was, "If the thermoluminescent dosimeter (TLD) that traveled in the weather balloon experienced 2 times more radiation than the TLDs on the surface of Earth then the atmosphere blocks 50% of the radiation from entering the Earth."

What Are Thermoluminescent Dosimeters?

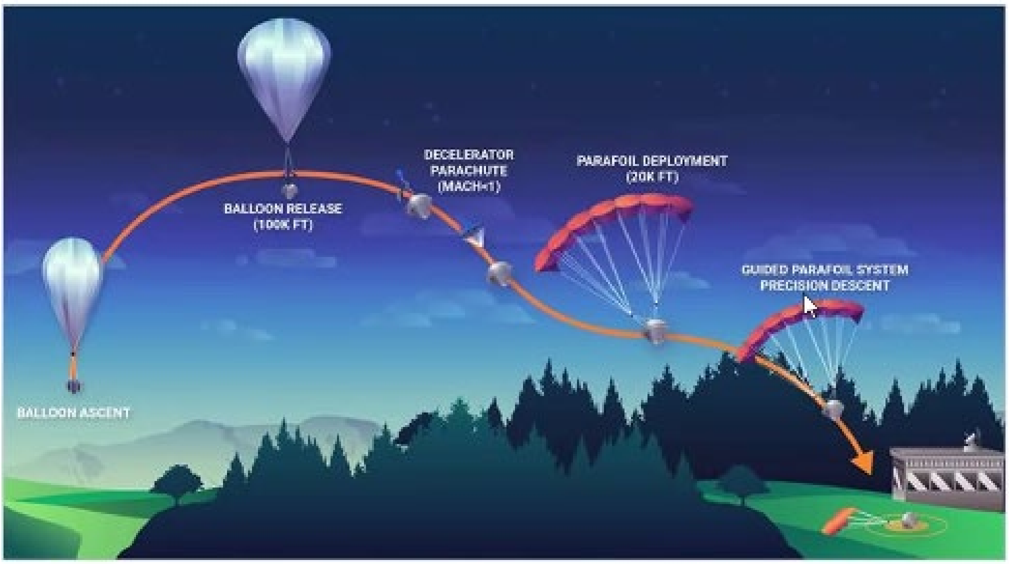
Thermoluminescent dosimeters, also known as TLDs, are devices used to measure radiation. TLDs are oftentimes used in labs to ensure that the scientists are safe and in other work sites.

TLDs are phosphors, commonly composed of lithium fluoride (LiF) or calcium fluoride (CaF) crystals. Once the radiation interacts with these phosphor crystals, which have impurities within them that trap electrons from the ionizing radiation, it allows them to absorb radiation

To measure the amount of radiation received by the TLDs, heat is applied to the crystal which causes it to emit photons. The amount of light emitted correlates to the radiation received by the TLDs. Inside the TLDs is a chamber with air. When it is exposed to radiation, some of the atoms in the air become ionized, causing static electricity to discharge in response to the amount of radiation received. After the amount of emitted light is measured, it is calibrated. The calibration process uses a standard ratio to calibrate the amount of radiation received based on the photons that were released from the TLDs. Using the calibration process, the radiation can be calculated and used for reference or research.

Weather Balloon Specifications

As a part of Janet's Planet Astronaut Academy, we were first introduced to SpaceWorks by Shawn Case. We were given the incredible opportunity to launch an experiment on a weather balloon. The weather balloon was launched in October 2021 in Madras, Oregon. It flew to 100K feet high and landed a couple hours after departure. As our experiment was inside the weather balloon for the duration of the experiment, it may have blocked alpha rays or other less-penetrating forms of radiation. Nonetheless, the experiment still demonstrates the difference between the radiation received in higher altitudes versus on the surface of Earth.



What Factors Affected this Experiment?

Radiation exists virtually everywhere, therefore it can be difficult to produce an unaffected measurement of radiation. A few factors that possibly affected this experiment are:

- **Elevation**
  - When at different elevations, your relation to space along with the atmosphere changes. Space emits much more radiation than the normal dosage on Earth because you do not have the atmosphere to protect you.
- **Packaging**
  - In the case of this experiment, the packaging of the TLD is the Weather Balloon. Although the Weather Balloon is crucial to this experiment, it can deflect some of the radiation. To provide context; radiation rays such as gamma rays can penetrate through almost anything, whereas alpha rays can be stopped by a substance as little as a thin piece of paper.
- **Time**
  - Before being placed in the Weather Balloon, the TLD spent a few days in the SpaceWorks lab. As radiation can be found everywhere, the TLD could have picked up radiation in the laboratory which can affect the experiment and extra radiation to the experiment.
  - This can also be applied to the TLDs that did not travel to the atmosphere. Like mentioned before, radiation can be found everywhere. The extra radiation could have been recorded on the TLDs, thus affecting the experiment and giving us untrue results.

- **Measurement differences**

- When the TLD was measured, it may have been measured accumulatively, meaning that both the normal radiation levels received on Earth and from the flight in the weather balloon were added. Contrary to the aforementioned method, the measurement may only be of the additional radiation received that would not normally be seen at sea level.

Results

The data stated that 135 mrem of deep radiation was received and 136 mrem of shallow radiation was received. Millirem, or “mrem” is a unit of radiation. It is 1/1000 of a rem, which stands for Roentgen equivalent man. Deep radiation means that it was likely gamma or possibly beta rays that can penetrate through your body. Shallow radiation means that it was most likely alpha or beta rays that do not penetrate very far or can even be reflected.

On average, humans – you – receive about 1.7 mrem of radiation per day, which is much less than what was received in the weather balloon. This proves that the atmosphere blocks radiation from space and more radiation is received the higher up in elevation you go, and therefore proving our hypothesis.

Conclusion

Our experiment tested the amount of radiation that gets blocked by the atmosphere and how much comes in contact with us here on Earth. Knowing the amount of radiation you received is important as it can impact your health and well-being. This experiment proved how much more radiation is received when reaching higher elevations, and how this can impact humans when in aircraft or even in space. A long exposure to radiation can cause diseases, such as cancer, cardiovascular diseases, skin burns, etc.

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