Effects of Carbon-14 Radioactivity Variations in Medical Dosimetry

Emma Kurth & Dr. Hitt

Introduction

- The half life decay period of a radioactive isotope was said to be a constant
- There were no discoverable environmental causes that could affect or change the time at which an isotope decayed
- Ephraim Fishbach claimed that the emission of neutrinos from Solar Flares and different Sun-Earth distances, caused fluctuations in the decay rate of radioactive isotopes
- Neutrinos are elementary particles that have a very small mass which are; therefore, difficult to detect.
- Other recent studies have taken several different isotopes into account
- Carbon-14 is a radioactive isotope which was experimented on
- Carbon-14 is primarily used in Medical Dosimetry for radiation therapy and treatments in cancer patients
- Medical dosimetrists administer specific doses of C-14 which are precisely generated to target malignant tumors within the human body
- Fluctuations in the decay rate of Carbon-14 could affect the dosages of C-14 administered in Medical Dosimetry

Materials & Methods

- the Khalifa University campus in Abu Dhabi, United Arab Emirates had a specific room that was dedicated for counting several radioactive isotopes
- The detectors for each radioactive isotope were set up as shown in Figure 1.

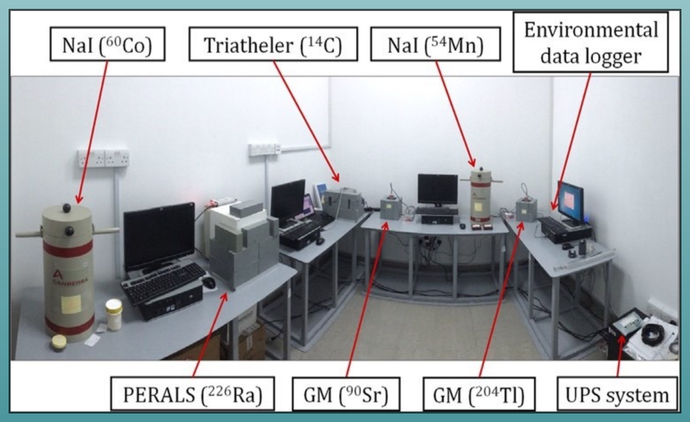

Figure 1: Laboratory setup highlighting important experimental equipment

- An environmental data logger was set up to record temperature, humidity, pressure, and overall changes in environmental conditions every 10 min was added to the room in order to represent any fluctuations and differences to the starting condition.
- Liquid scintillation counters are used for counting beta-emitters
- The Triathler multilabel tester liquid scintillation detector was used to count the pure beta emitter Carbon-14.
- Over a course of about two years, 11 December 2014 through 13 December 2016, the counter recorded measurements every 30 min over that time period.

Results & Discussion

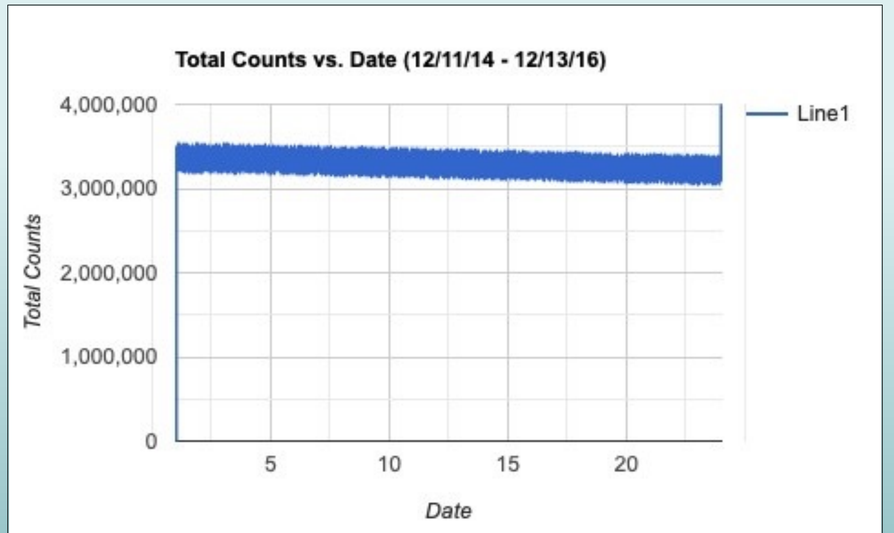

Figure 2: Relationship between Total Counts of Carbon-14 over the time period of December 2014 through 2016.

- When analyzing the Total counts over the 2-year period, it is noticeable that the trend seems to stay constant throughout the time data was being collected.
- The half-life decay of Carbon-14 has been said to be about 5700(30) years.
- What can be seen in Figure 2, is that the total counts of Carbon-14 move in a slight downward direction, which is unusual since the time period of its half-life decay is very large.
- This could be due to multiple plausible reasons, in which the effect of neutrinos does not play a role in.

- The molecular compound of the solution used in the liquid scintillator was not remade throughout the process which could have led to variations and degradation of the counter, causing a negative slope.
- All other factors such as air pressure, humidity, and temperature seemed to not have impacted the counts of Carbon-14.
- If there had been effects from other environmental influences, oscillations or high and low peaks would have been detected.
- Based on the data, there were no factors significantly influencing the Carbon-14 decay, to the point at which conclusions could be drawn.

Conclusions

- In recent studies, there have been indications that the half-life decay of radioactive isotopes could be affected by environmental and external factors.
- Investigated the possibility that the decay constant may be oscillating because of the Earth-Sun distance as well as Solar flare activity potentially due to Neutrino emissions.
- Consequences of an oscillating decay rate of Carbon-14 could affect the field of Medical dosimetry because it would cause reevaluations and recalculations of Carbon-14 doses administered to cancer patients, during different times of the year.
- Based on the results, it shows that there are no significant factors that could greatly affect the decay rate to the degree that it would make a notable difference for allotted doses.

Bibliography