Gamma Ray Spectroscopy

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ABSTRACT

We studied the nucleic properties of 7 known and 1 unknown radioactive samples using the method of gamma ray spectroscopy. Our findings agreed well with the spectra of well known elements.

1 Introduction

The study of the energy spectrum of gamma rays emitted by radioactive elements is known as gamma ray spectroscopy. Most radioactive sources produce gamma rays in decay, which can be detected at various energies and intensities to form a unique fingerprint for the source. These emissions are detected with a scintillation counter and analyzed by a multichannel analyzer to be plotted and usable by a computer. A detailed analysis of this spectrum is useful in fields of physics such as astronomy, nuclear physics, and geochemistry. In this experiment we will be comparing many spectra emitted by different radioactive samples found in the lab.

2 Experimental Setup

The experiment setup is showed in Figure 1. We use a scintillator counter and a modular electronics in order to obtain the gamma spectra. During this experiment, the scintillator generates photons in response to incident radiation from the samples [insert cited]. This creates a pulse of near-visible/ visible light. The pulse of light is captured and converted to amplified electrical signal by a photomultuplifer (PMT). PMt use photoelectric effect to intensify the imagines, where it direct the excited electrons to dynodes in order to produce secondary emission. After that, a pulse height analyzer (PHA) digitizes the voltage from the PMT and amplifies its signal. We can obtain gamma energy measurement through the amplitude of this signal.

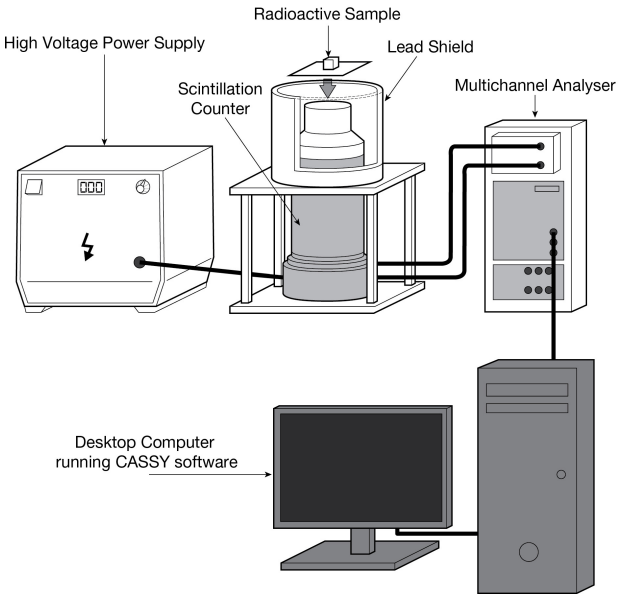

Figure 1. Lab equipment for detection of gamma radiation spectra by scintillation counter. The counter outputs to the multichannel analyzer which formats data and feeds it to the computer

3 Result

For Ba-133, the expected values for Compton edges are at E = 210 keV[7]. Our collected data (Figure 2 (a)) displays the values of E = 220 roughly. In addition, comparing the Figure 2 (a) and (b), our collected spectra has similar peaks to the sample spectra.Besides, our collected spectra also displays the peaks comparing to to the sample spectra (Figure 4 (b)). Thus, we can assume that the obtained result for Na-22 and Ba-133 are fairly good. Similarly, by comparing Figure 6 (a) and (b), both spectra show the characteristic peaks of Eu-152 and the values of these peaks are +/- 30 keV different.

Looking at Figure 3 (a), even though we could not obtain a good signal, however our spectra still has a similar shape to Figure 3 (b). We cannot assume if this is the correct spectra for C-14 because of the half peak at the beginning of the collected spectra.

For Po-210 (Figure 7) and Co-57 (Figure 5), we did not successfully obtain the correct spectra for these sample. Comparing our Figure 7 (a) to Figure 7 (b) as well as Figure 5 (a) to (b), we can clearly see that the collected spectra do not have the characteristic peaks of the samples. We believe this happens due to the age of the samples in the lab. Since these samples are fairly old, other closed-by samples that are newer can potentially interfere with our signal during the process. Besides, we could not find a sample spectra for Tl-204, but we obtained a spectra for this sample (Figure 8 (c)). Although we cannot conclude whether collected spectra is good or not, we can see our collected spectra is fairly distorted.

By accessing our collected spectra, we determine that our unknown sample spectra (Figure 8 (a)) has peaks at 30 keV, 80 keV, and 650 keV. These peaks are the same as Cs-137 sample (Figure 8 (b)). This spectra also has peaks at 160 keV, 300 keV, and 350 keV which is similar to spectrum of Ba-133 and Eu-151. However, since the unknown source does not display any energy peaks above 1000 keV, we determine that Eu-152 sample does not aplly in our case. We assume that our unknown sample is a mixture of Ba-133 and Cs-137.

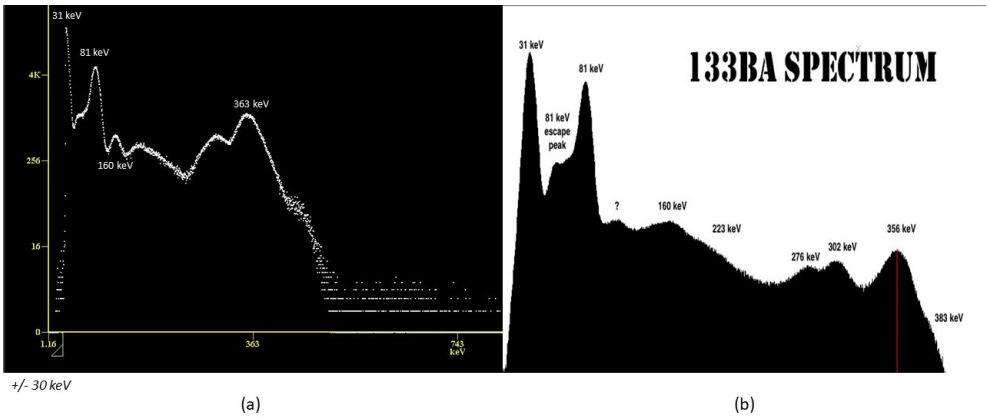

Figure 2. (a) This is our collected spectra from Ba-133 sample (b) Ba-133 spectra sample from Gamma Spectacular[2].

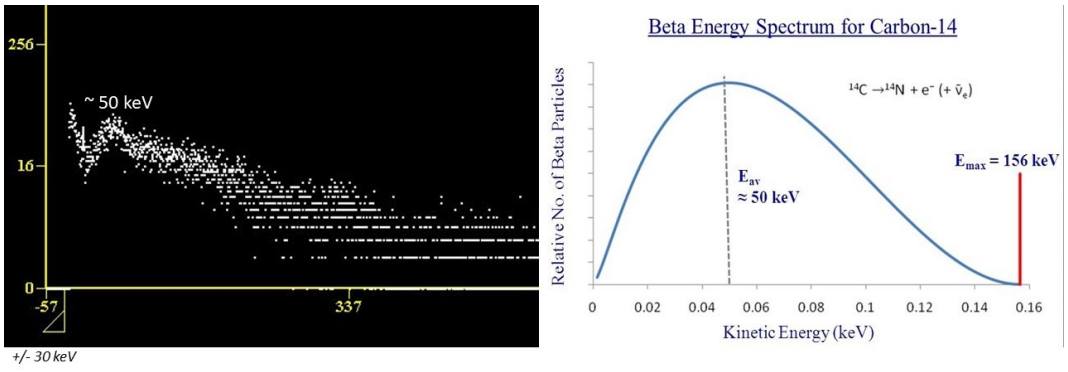

Figure 3. (a) This is our collected spectra from C-14 sample (b) C-14 spectra sample from Socratic.org[6]

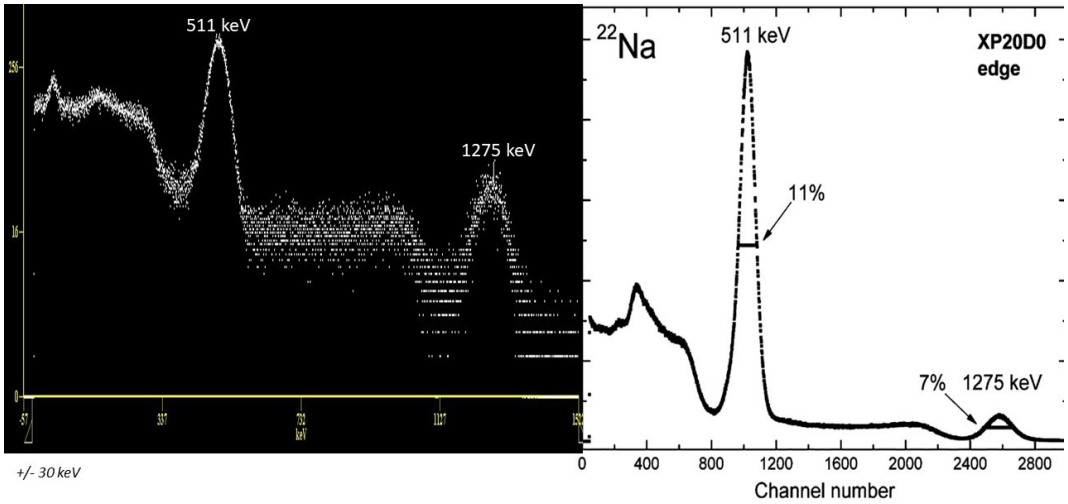

Figure 4. (a) This is our collected spectra from Na-22 sample (b) Na-22 spectra sample Research Gate[1].

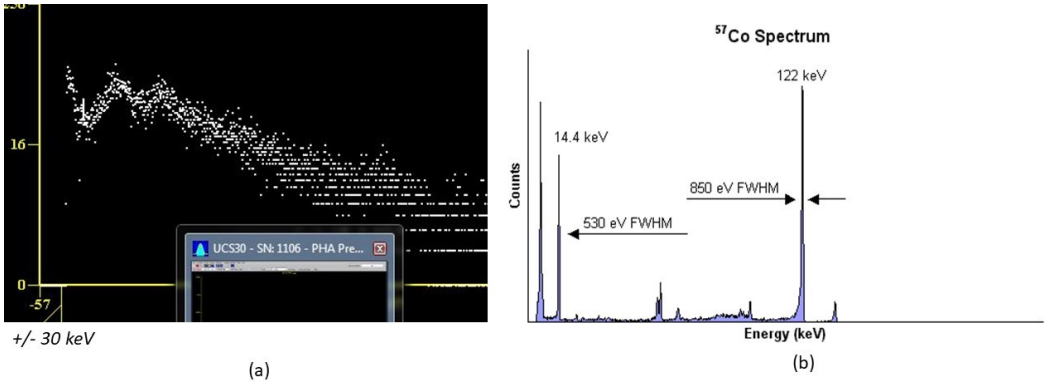

Figure 5. (a) This is our collected spectra from Co-57 sample (b) Co-57 spectra sample from Amptek[3]

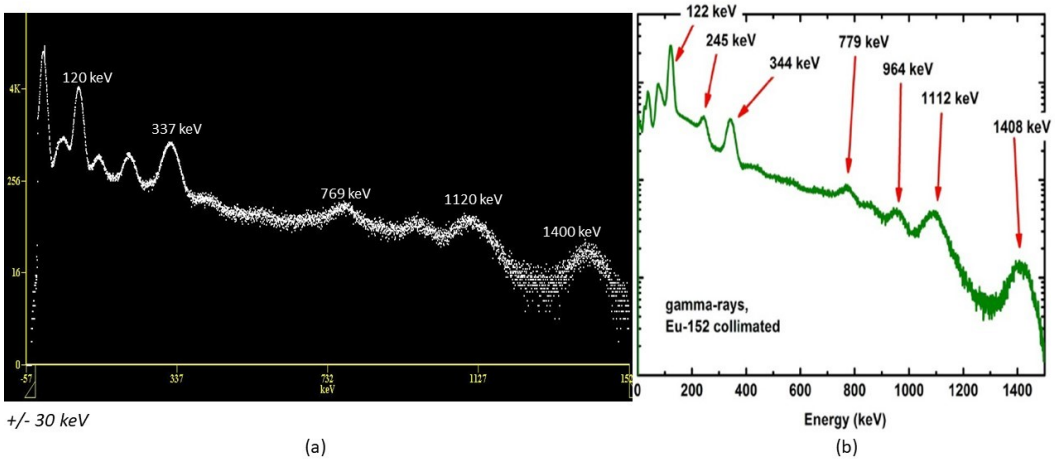

Figure 6. (a) This is our collected spectra from Eu-152 sample (b) Eu-152 spectra sample from Journal of Instrumentation[4].

4 Conclusion

All of our collected sample are found within the expected values of peaks except for Po-210, Co-57, and Tl-204. We assume that some of our spectra is contaminated by Cs-137. For example, our Po-210 spectra has a couple

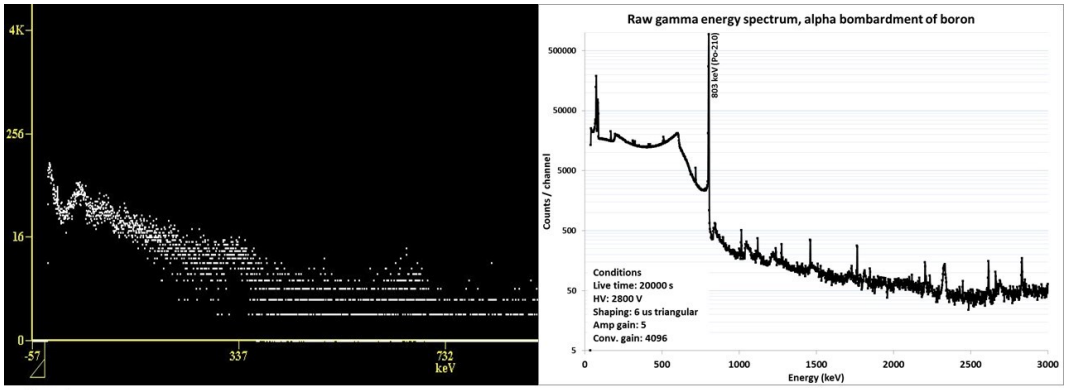

Figure 7. (a) This is our collected spectra from Po-210 sample (b) Po-210 spectra sample from Special Nuclear Material[5]

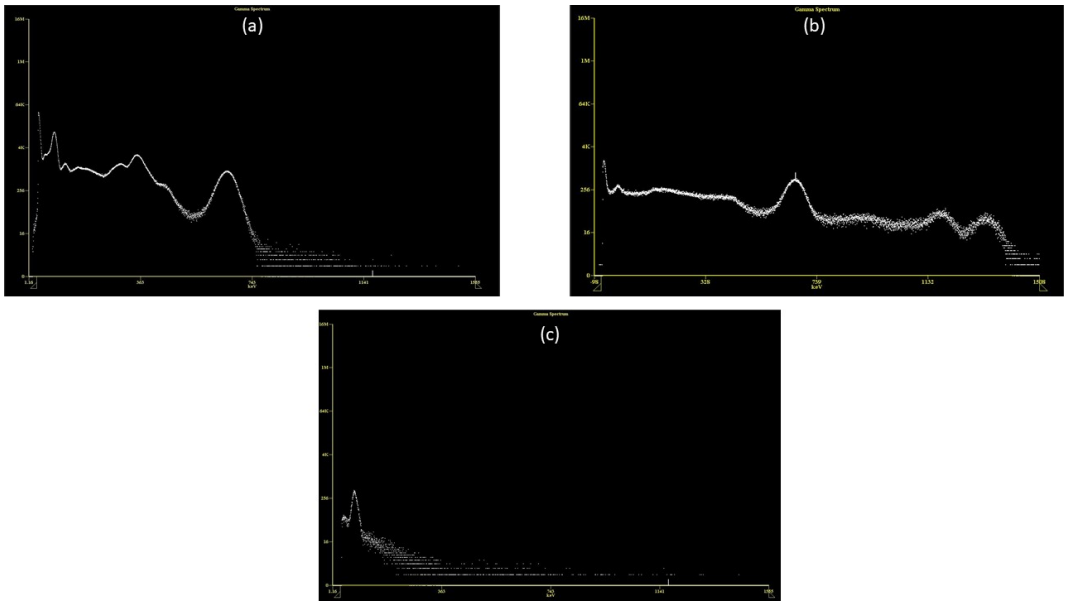

Figure 8. (a) This is our collected spectra of the unknown sample (b)Our calibration spectra using Cs-157 and Co-60 (c) Our measured spectra for Tl 204

characteristic peaks of Cs-137 sample. In order to reduce contamination, we need remove other samples from our working area. Besides, we determined that some of our peak values are fairly off. This happens because we did not re-calibrate the system when needed.

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