22.01 Fall 2015, Problem Set 5 (Laboratory)

Due: November 3rd, 11:59PM on Stellar

October 27, 2015

Complete all the assigned problems, and do make sure to show your intermediate work. Please upload your full problem set in PDF form on the Stellar site. Make sure to upload your work at least 15 minutes early, to account for computer/network issues.

Laboratory Assignment

High-Efficiency Banana Activity Estimation

1. Using the attached data from our counting experiment of $58.4 \pm 0.5\,lbs.$ of bananas, calculate the specific activity of one banana. Quantify your uncertainty as well as you can, knowing that both the background signal and the sample signal were collected for exactly 24 hours.

2. Identify any peaks present in the photon spectrum accumulated during our experiment. Explain their mechanistic origins, and why you observe them.

3. Imagine that instead of the small, high-purity Ge (semiconductor) detector, that we had used a very large NaI detector. Draw what you think the photon spectrum would have looked like.

Low-Efficiency Banana Activity Estimation

1. Using your Geiger counter (or that of a friend), estimate the specific activity of one banana, knowing that the ashes are from $122.1 \pm 0.5\,lbs.$ of bananas. Quantify your uncertainty as well as you can. You will have to perform your own background calibration. You may want to proceed using the following steps:

   (a) Calculate the solid angle from the banana ashes to your Geiger counter. This tells you the fraction of gamma rays emitted from the bananas that actually go in the direction of your counter.

   (b) Calculate the expected attenuation of K-40 gamma rays between the banana source and your Geiger tube. This tells you how many photons will be absorbed on the way to your detector.

   (c) Calculate the efficiency of your Geiger tube, by performing (a-b) using a known source with a known activity, and comparing your count rate to the expected one. You may use the value from Lab 4 if you have it.

   (d) Convert your count rate to an activity, by using the answers from (a-c).

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