Physics 111
Experiment # 7
## Radioactive Decay of Barium

Introduction

There is no simple way to influence the random decays of radioactive nuclei. Heating or cooling, changing the pressure, etc., all have no effect. The rate at which the nuclei decay is determined by the nuclear structure. If we know the number of nuclei present and the rate of decay, we can predict how many nuclei will remain at some future time (at least within some statistical uncertainty).

The number of radioactive decays per second (the *activity* of the sample of nuclei) may be plotted as a function of time. As the number of remaining nuclei decrease, so will the activity.

The equation relating the activity to time is

$$A = A_0 e^{-/t} \; ,$$

where A is the activity after a time t, and A_0 is the initial activity. The experiment today is designed to investigate the time dependence of the activity and to determine the half-life of the sample of barium. The barium sample you have comes from washing a solution of 0.04 M HCl and 0.9% NaCl through a cesium filter and eluting the barium onto a holder. The cesium remains in the filter and decays into barium (with a half life of 30.7 years for the cesium) and the short-lived barium is washed out and collected. The decay is shown in the following diagram. The cesium beta decays into metastable barium and the barium decays by emitting a $0.662 MeV$ gamma ray. This gamma ray is what you'll be detecting.

http://en.wikipedia.org/wiki/File:Cs-137-decay.svg
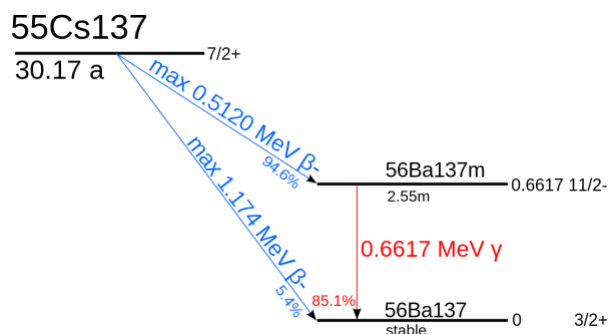
Procedure:

For this lab, we will be collecting data using a computer connected to a Geiger counter. Open the data acquisition program Capstone. From the menu on the right-hand side grab and drag the graph icon onto the middle of the screen. A graph should appear with no axes set. Do not worry about the axes yet.

Next, click hardware setup on the left-hand menu. A picture of the data acquisition box should appear. Clock on the picture where the Geiger counter is connected. Select *Geiger Counter* from the dropdown menu and then click hardware setup again to remove the picture. Click on the y-axis on the graph and choose Geiger counter (counts/sample). On the x-axis time should be set automatically as the default.

When you are ready, you will receive a drop of radioactive barium on a piece of an index card. Place the sample on a holder under the Geiger counter, click record and wait about 30 minutes for the data to collect. Move as far away as you can from the radioactive sample during the data collection. The data will appear very random at first and you should see the number of counts per second (the activity) decrease with time. After about 30 minutes you should have a reasonably smooth curve. Click stop on the data collection and fit the data with an exponential function.

Analysis:

From your plot of the data on the activity of the sample versus time, what is the equation for activity of barium as a function of time? What do the exponent of your curve fit and the proportionality constant represent? What is the decay constant and half-life of $^{137}_{56}Ba^*$?