

Fitting Data to a Curve: The Decay of ^{137}Cs

This exercise is to fit some data for radioactive decay as a function of time, including a constant background term. The number of counts $-\Delta N > 0$ detected in time Δt is called the decay rate $R = -\Delta N/\Delta t \approx -dN/dt$. Quantum mechanics tells us that R is proportional to N , the number of radioactive nuclei present at time t . That is $dN/dt = -\lambda N$ for some positive constant $\lambda = 1/\tau$, where τ is called the “lifetime” or “mean life.” Therefore

$$N(t) = N_0 e^{-\lambda t} \quad \text{and} \quad R = \lambda N_0 e^{-t/\tau} = \lambda N_0 2^{-t/t_{1/2}}$$

where, for convenience, we often use the “half life” $t_{1/2}$ instead of the lifetime.

Download the file **Cs137.dat**. It has two columns, the first is time (in 20-second intervals) and the second is the number of detected decays during that time interval. The data was taken as part of an undergraduate physics laboratory experiment, where samples of radioactive, but very long lived, ^{137}Cs were used to separate out the radioactive daughter ^{137m}Ba . This relatively short lived isomeric state in turn decays to the ground state by emitting a gamma ray. These gamma rays were detected by a Geiger counter as a function of time. You’ll see from the data that a constant background level persists after the ^{137m}Ba has decayed away.

The goal of this exercise is for you to fit an appropriate functional form to this data and to determine the half life of the ^{137m}Ba isomer. It should be easy enough for you to find the accepted value for the half life on the web, and compare it to your result.

Your notebook should include the following:

- Importing the file **Cs137.dat**.
- Defining your fit function and fitting the data to it.
- A plot of the data as a function of time, with your fit function superimposed on it.
- A plot of the difference between your fit function and the data as a function of time.

An appropriate time unit to use for the half life is minutes. I suggest you operate on the data file so that the 20-second time bins are in fact labeled as thirds of minutes.

Send the grader an email with your notebook as an attachment.