Ps 3 Problem 3

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Abstract

This document has an outline of a program that calculates and plots the an example radioactive decay of 10,000 atoms Bismuth 213 into Bismuth 209.

1 Introduction

Radioactive decay is a random process, so you can really only calculate an accurate trajectory by using a random method. This program does so for 10,000 Bismuth into Bismuth 213 with stops along the way into the intermediaries.

2 Methods

The code is pretty simple. Probability for some atom to decay in some time t is given by equation 10.3 in Newman: $p(t) = 1 - 2^{\frac{-t}{\tau}}$, where τ is the half life of that atom. Working from the lowest atom up to prevent double counting, choose a random number, if it is less than the decay rate, then decay and add another copy of the next atom down the line. There is a small potential detour where Bismuth 213 can decay into one of two different particles. I added another random number generator to give a weight for the decay into one of the two possibilities.

3 Results

The Tl atoms are more or less ignorable, but were still included. If they had a longer half lives they might have built up, but the half life for Tl is about the half life for Pb, but it is only 1/50th the total number of Pb at most (realistically much less) and the amount going into Tl from Bi 213 decay is much much less than the amount leaving due to decay because the Bi 213 half life is much longer than either of it's products.

4 Discussion

We get exponential decay curves as expected. It may be possible to ignore the working bottom up method by using some other algorithm like the Gillespie algorithm or something, but for our needs a direct calculation and for loop is more than enough.

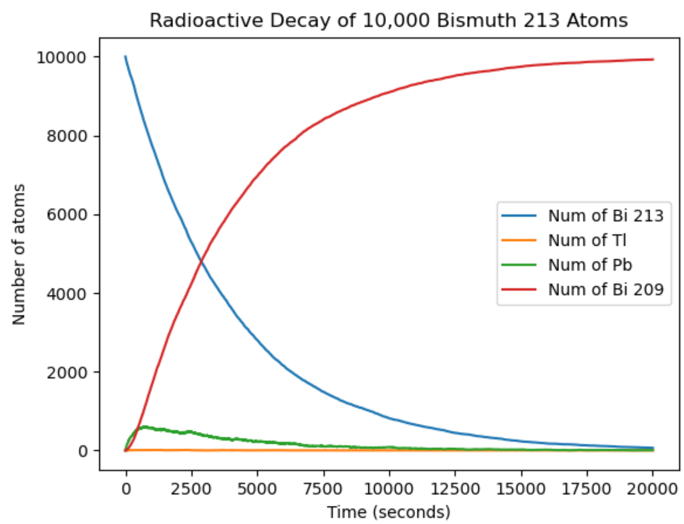

Figure 1: Exponential curves as expected. All of the atoms are turned into Bi 209 by the end.