Vega Hitti

260 381 396

PHYS 512 – Q2

For part a), I converted the half-lives of all of the products in the U238 chain into seconds. I obtained the half-lives from the PowerPoint slides shown in Lecture 6 (see below).

	Half-Life	Time unit	Emitter
Uranium-238	4,468	billion of years	alpha
Thorium-234	24,10	days	beta -
Protactinium-234	6,70	hours	beta -
Uranium-234	245 500	years	alpha
Thorium-230	75380	years	alpha
Radium-226	1 600	years	alpha
Radon-222	3,8235	days	alpha
Polonium-218	3,10	minutes	alpha
Plomb-214	26,8	minutes	beta -
Bismuth-214	19,9	minutes	beta -
Polonium-214	164,3	microseconds	alpha
Plomb-210	22,3	years	beta
Bismuth-210	5,015	years	beta
Polonium-210	138,376	days	alpha
Plomb-206	Stable		

Figure 1: Half-lives of all the Products in the U238 Chain

Then, to evaluate the ODE, I used scipy.integrate.solve_ivp() and set the method parameter to "Radau". This means it was solved implicitly. I chose the "Radau" method over the default Runge-Kutta method because it is much more efficient. Indeed, the Runge-Kutta method uses many more function calls than the implicit method, and it takes significantly longer to compute. Since we are working with 15 species and a timespan of the order of 10^{17}, it is a good idea to maximize efficiency. Also, it was pointed out in class that the Runge-Kutta method is much worse at handling oscillation than the implicit method.

In part b), I plotted the ratio of Pb206 to U238 over time as well as the ratio of Thorium 230 to U234 over time (see below).

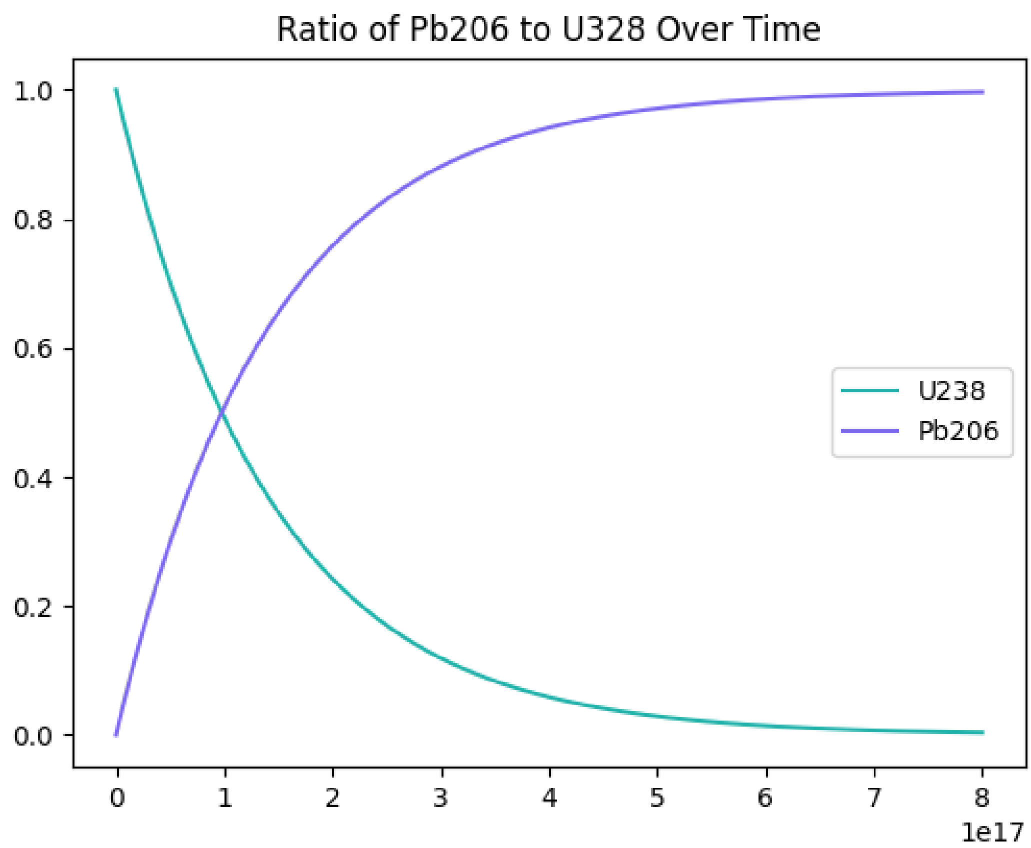

Figure 2: Ratio of Pb206 to U238 Over Time

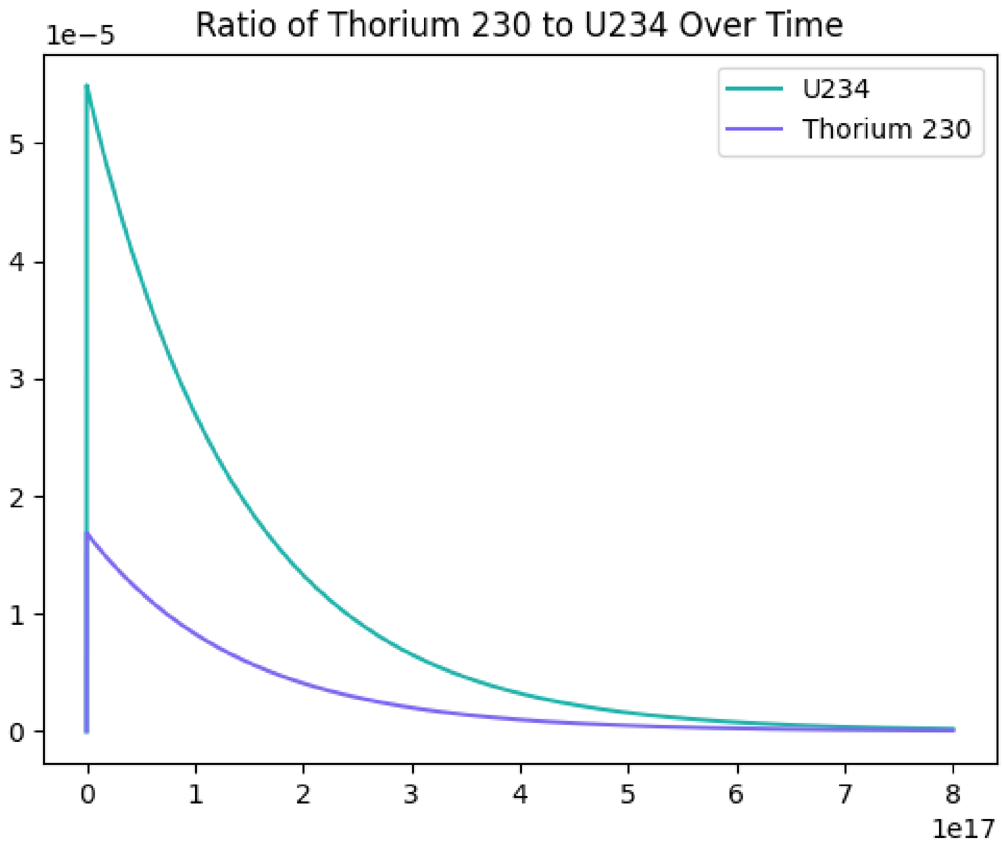

Figure 3: Ratio of Thorium 230 to U234 Over Time

As seen in Figure 2, the rate of decay of U238 appears to be proportional to the rate of growth of Pb206. This makes sense analytically, because the half-life of U238 (4.468 billion years) is much larger than the sum of the half-lives of every other product in the chain. So, we can reasonably approximate that U238 decays directly into Pb206.