Computational Physics Project Proposal

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I. RADIOACTIVE DECAY

An unstable nuclei decays to some other nuclei by different modes of radioactivity. The general law of radioactivity, as we know, that the rate of decay of a nuclei is given by

$$\frac{dN(t)}{dt} = -\lambda N(t) \tag{1}$$

where λ is the decay constant of the nucleus.
In classroom lecture 2, the problem of long decay chain was discussed, where the parent nucleus undergoes a series of decays and the numerical method to solve this problem to get the concentration of nucleus in the decay-chain was dicussed. But the problem was stated ill-posed for the fact if the half-lives or in other words the decay constants of the nuclei in the decay chain varies a lot. The problem discussed in class was for a number of nuclei, where the decay of the kth nucleus is given by the equation 2,

$$\frac{dn_k}{dt} = \lambda_{k-1} n_{k-1} - \lambda_{k-1} n_{k-1} \tag{2}$$

To make the numerical calculation easy I would like to reduce this problem to two nuclei, say N_1 and N_2, such that as N_1 decays to N_2.

A. The Problem

Consider the two nuclei with initial concentrations as $N_1(t)$ and $N_2(t)$, at any time t. Suppose the nucleus N_1 decays to N_2, which decays further according to the equations,

$$\frac{dN_1}{dt} = -\lambda_1 N_1 \tag{3}$$

$$\frac{dN_2}{dt} = \lambda_1 N_1 - \lambda_2 N_2 \tag{4}$$

where λ_1 and λ_2 are the decay constants of the two nuclei.
In this project, I wish to solve these equations 3 and 4, which are simple differential equations, for N_1 and N_2 as functions of time using Euler's method.
This problem can be further solved for different values of λ_1 and λ_2, such that their ratio varies largely. The same problem can also be solved analytically for N_1 and N_2 at long or short times.
The approximate solution can be compared with the exact solution to know how the error changes with different time step in the Euler method calculation by plotting the obtained solution with time.