Given a large number of atoms, we may treat the number of atoms $N$ as continuous. The rate of decay is proportional to the number of nuclei. We can write

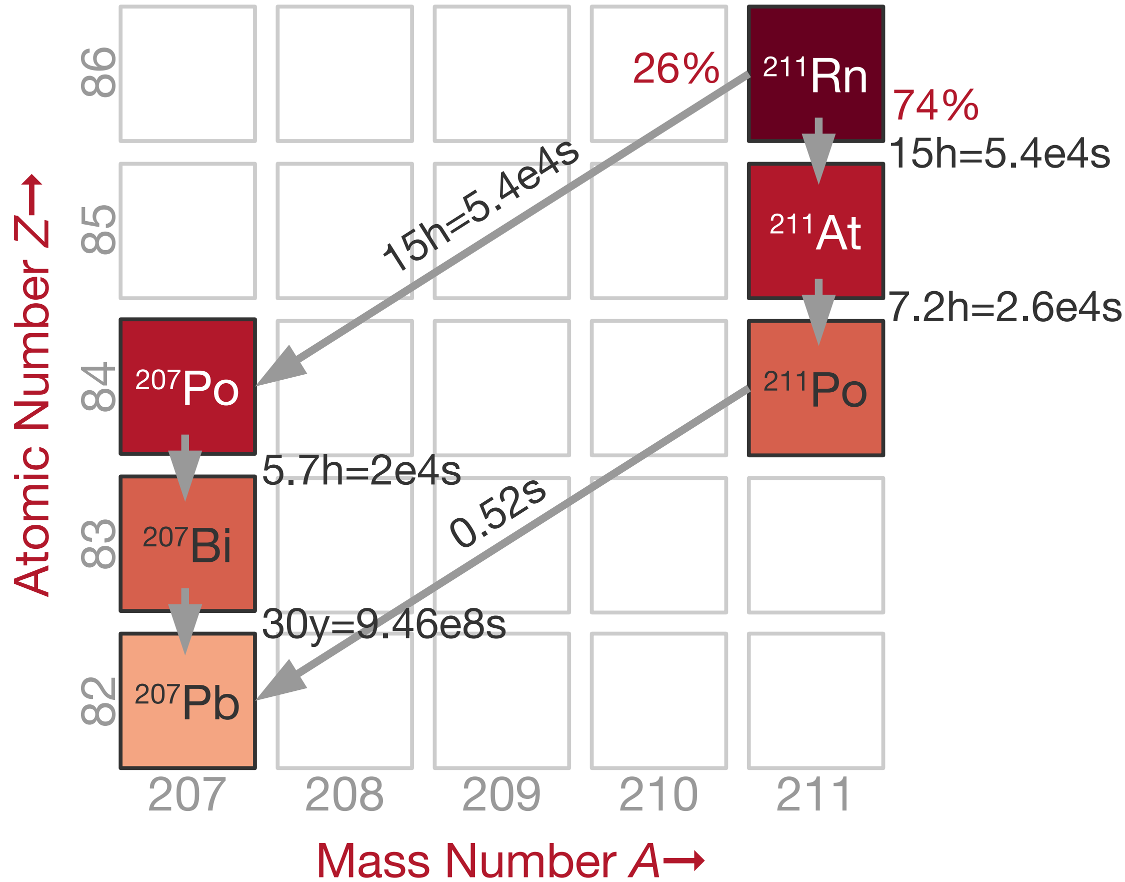
$$\frac{dN}{dt} = -\lambda N$$

where $\lambda$ is the decay constant characteristic of the material.

One advantage of modeling this system is that it has an analytical solution which we can use to assess the different methods of numerical solution that we will employ:

$$N(t) = N_0 \exp(-\lambda t)$$

where $N_0$ is the initial amount of the material.




Radon-211 decays via two competing chains to the stable lead-207 as illustrated above. First we need to cast this reaction into a matrix form so that we can feed it into the ODE solver.

$$\frac{dN_{Rn}}{dt} = -\lambda_{Rn} N_{Rn}$$

$$\frac{dN_{At}}{dt} = 0.74\,\lambda_{Rn} N_{Rn} - \lambda_{At} N_{At}$$

$$\frac{dN_{Po-211}}{dt} = \lambda_{At} N_{At} - \lambda_{Po-211} N_{Po-211}$$

$$\frac{dN_{Po-207}}{dt} = 0.26\,\lambda_{Rn} N_{Rn} - \lambda_{Po-207} N_{Po-207}$$

$$\frac{dN_{Bi}}{dt} = \lambda_{Po-207} N_{Po-207} - \lambda_{Bi} N_{Bi}$$

$$\frac{dN_{Pb}}{dt} = \lambda_{Po-211} N_{Po-211} + \lambda_{Bi} N_{Bi}$$