Introduction to Nuclear Chemistry I

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Chart of the Nuclides

- The nuclear scientists' equivalent of the periodic table.

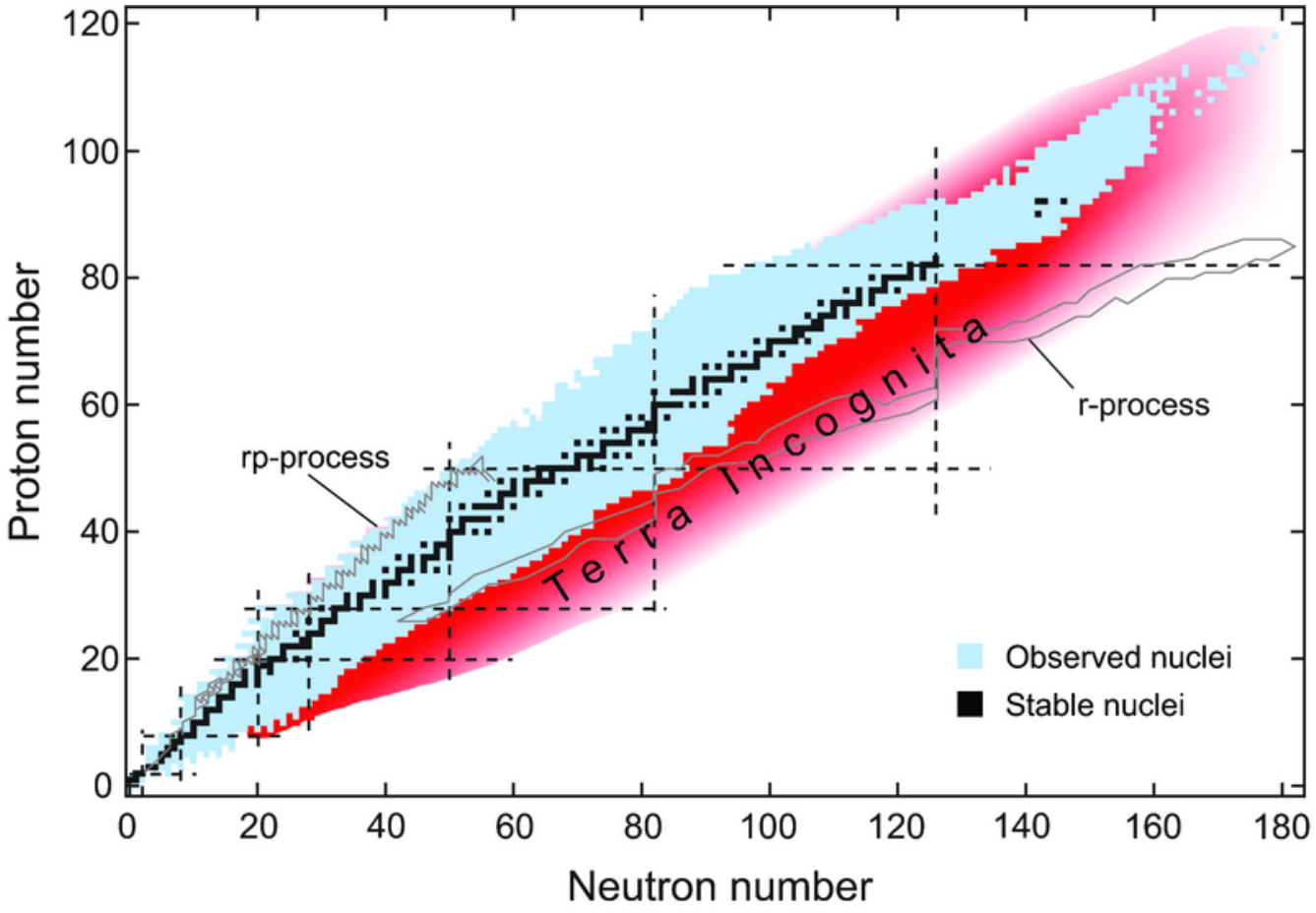
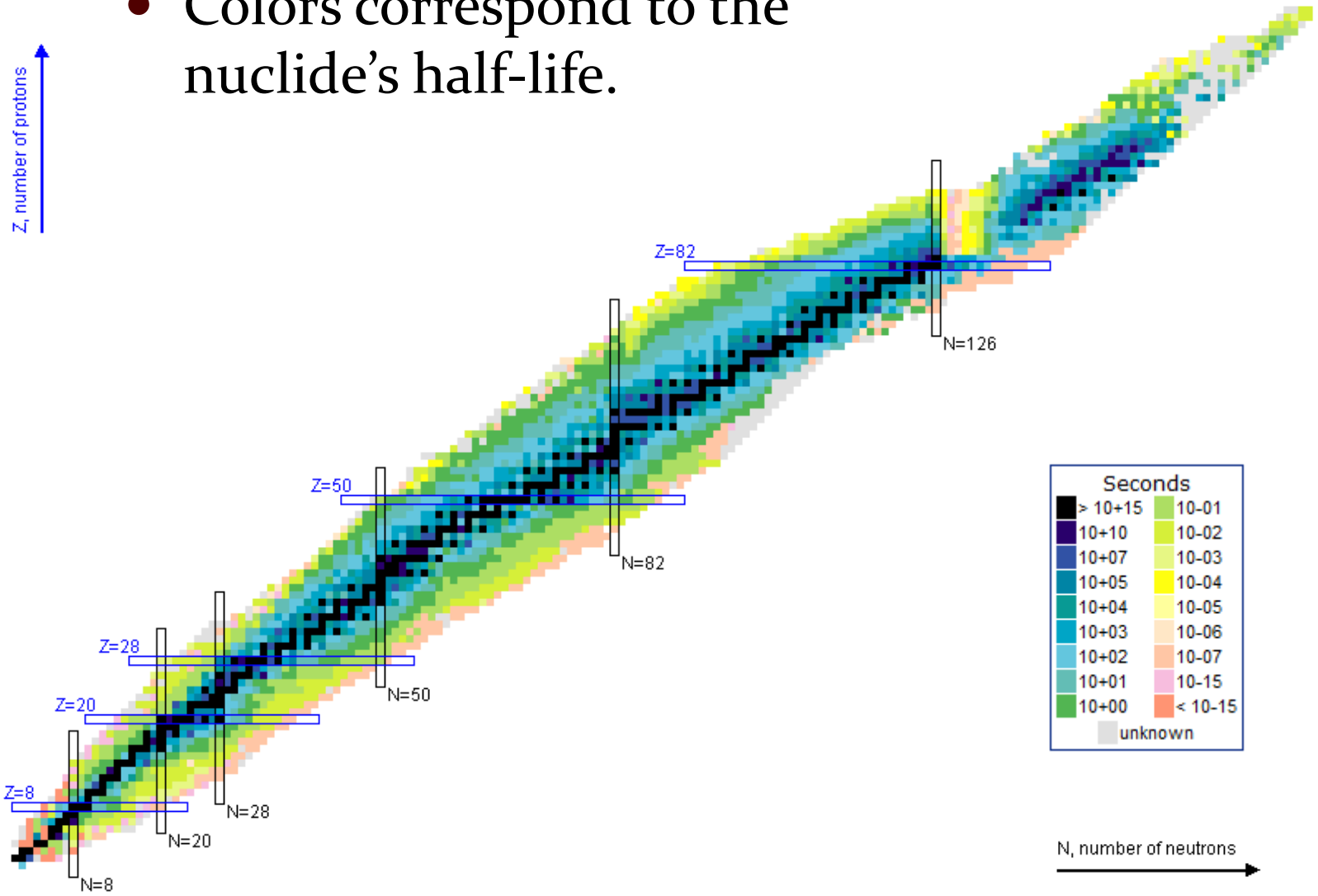


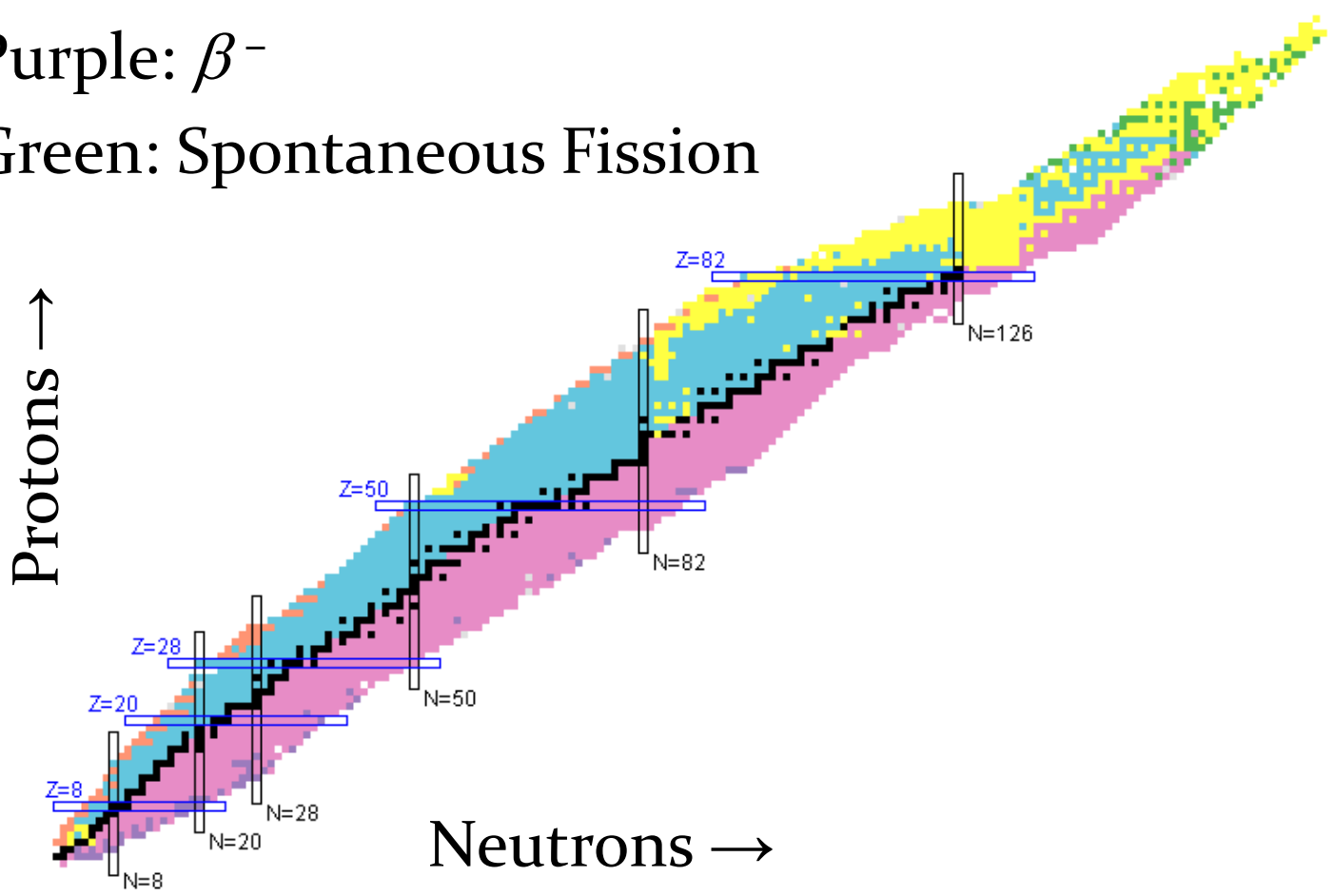
Chart of the Nuclides

- Colors correspond to the nuclide's half-life.



Where are the different beta decay modes favored?

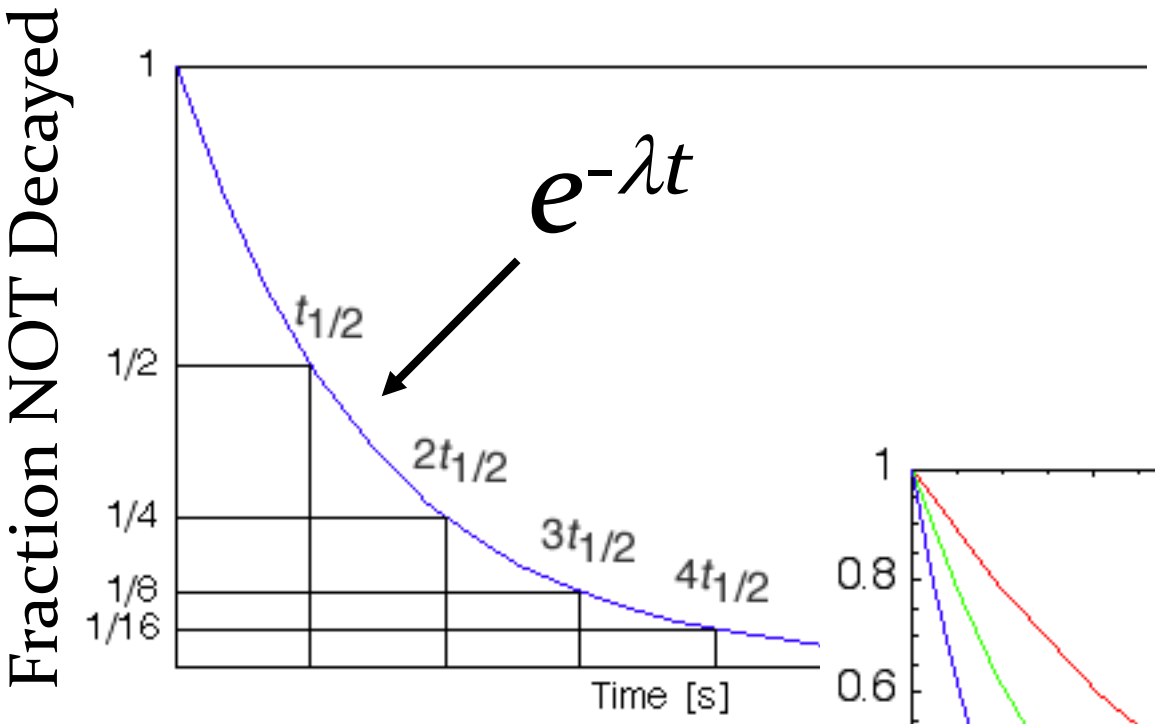
- Yellow: α
- Blue: β^+
- Purple: β^-
- Green: Spontaneous Fission



Example

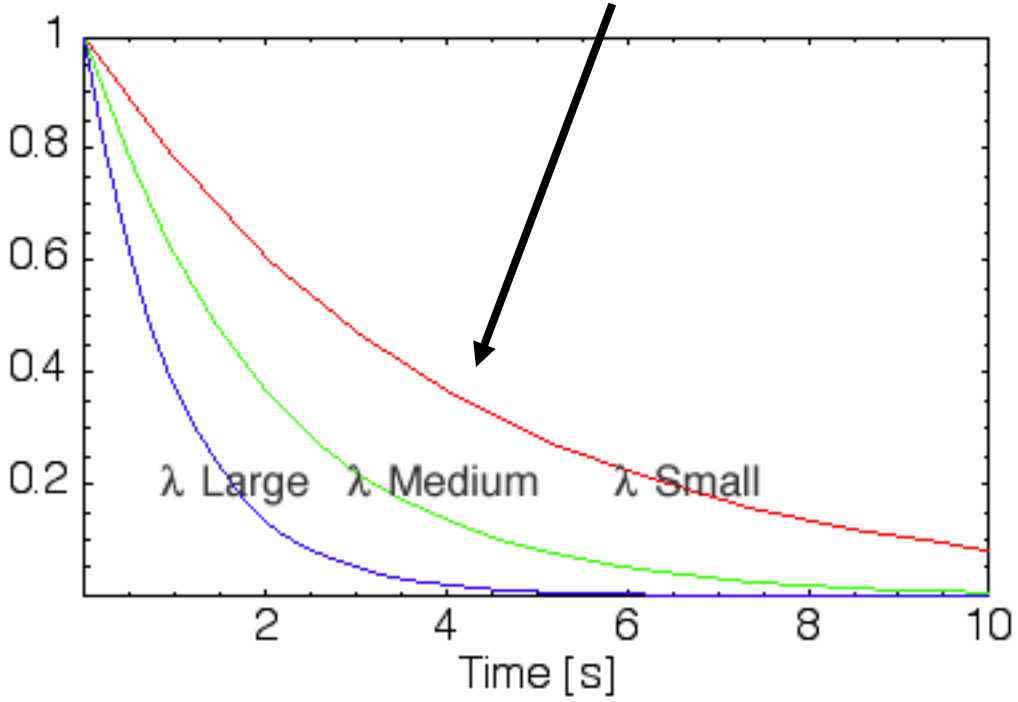
- What is the activity of 1 kg of $^{232}ThO_2$ in decays per second (s^{-1})? The half-life of ^{232}Th is 1.40×10^{10} y and its atomic weight is 232.038 g/mol.

Radioactive Decay



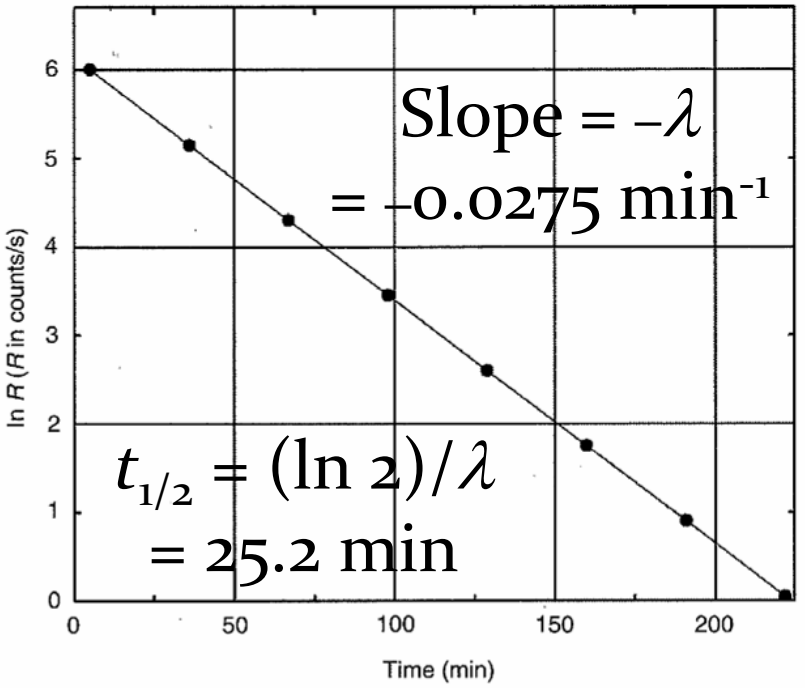
- Radioactive decay follows an exponential decrease.

- Nuclei with large λ have a faster decay rate than a similar number of nuclei with a small λ.



How do you measure the half-life?

- The *half-life* $t_{1/2}$ is the time it takes for half a sample to decay away.
- How do you measure $t_{1/2}$?
- Start with: $A = A_0 e^{-\lambda t}$
- Re-arrange: $\ln A = -\lambda t + \ln A_0$
  - Measure A vs. time.
  - Plot the data.
  - Measure the slope. This is $-\lambda$. Calculate $t_{1/2} = (\ln 2)/\lambda$.
  - Measure the intercept. This is $(\ln A_0)$.



Our Very Existence

- There is a very important radioactive decay that you should know about:

$$n \rightarrow p + e^{-} + \bar{\nu} + \text{Energy}$$

- These protons are fused into heavier elements by stars, releasing energy in the process.

- Neutrons alone cannot make atoms. If the reaction ran in the opposite direction then there would be *no elements*.

- You owe your very existence to nuclear science!