10

for $R \le r \le r_1$, $V(r) = \frac{1}{4\pi\varepsilon_0} \frac{2(Z-2)e^2}{r}$

$E = E$, the kinetic energy of the emitted α-particle

This equation is solved in FT. The solution is

$$T \approx \exp\left(-\frac{\pi\sqrt{2m}}{\hbar} \cdot \frac{V_0 R}{\sqrt{E}} + \frac{4\sqrt{2mV_0}\, R}{\hbar}\right)$$ This is not relevant here.

which has the form This is all that is necessary.

$T \simeq A \exp(-C/\sqrt{E})$ (1)

There's a nicely compact relationship between the decay constant γ and the transmission coefficient T, given on FT page 402: $\gamma = \frac{v_1}{2R} T$, where v_1 is velocity of α-particle in nucleus (2)

This simple approach is described as semi-classical.

This says: probability of decay in 1 second equals the number of times the particle hits the potential wall at $r = R$ times the probability that it will pass through; a strange fuse of Newtonian and quantum mechanics.

Rearrange (2) to give $T = \frac{2R\gamma}{v_1}$

(1) = (2) $A\exp\left(\frac{-C}{\sqrt{E}}\right) = \frac{2R\gamma}{v_1}$

$$\gamma = \frac{v_1 A}{2R} \exp\left(\frac{-C}{\sqrt{E}}\right)$$

$$\ln\gamma = \frac{-C}{\sqrt{E}} + \ln\left(\frac{v_1 A}{2R}\right)$$

$$\ln\gamma = \frac{-C}{\sqrt{E}} + K \text{ where } K = \ln\left(\frac{v_1 A}{2R}\right)$$

This is OK to quote formula, but derivations have no place in an essay.

This is a straight line graph of $\ln\gamma$ against $\frac{1}{\sqrt{E}}$, and observations fit very well. If the line is plotted for different ~~elements~~ nuclides, with γ varying by 24 powers of 10, the slope of the line whose eqtn is given above does not differ from observations by more than a few per cent.

I read in FT that α-particles do not exist inside the nucleus. I find this surprising. I would have thought