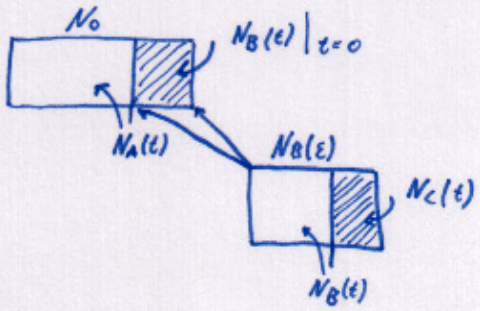
1) $A \rightarrow B \rightarrow C$
inst. inst. stab.

$\lambda_A \rightarrow \lambda_B$



a) $N_A(t) = N_0 \cdot e^{-\lambda_A t}$

$N_B(t) = (N_0 - N_A)\, e^{-\lambda_B t}$

$N_C(t) = (N_0 - N_A - N_B)$

↳ $N_B(t) = (N_0 - N_0 e^{-\lambda_A t}) e^{-\lambda_B t}$

↳ $N_C(t) = N_0 - N_0 e^{-\lambda_A t} - (N_0 - N_0 e^{-\lambda_A t}) e^{-\lambda_B t}$

b) $N_A + N_B + N_C =$

$N_0 \cdot e^{-\lambda_A t} + (N_0 - N_0 e^{-\lambda_A t}) e^{-\lambda_B t} + N_0 - N_0 e^{-\lambda_A t} - (N_0 - N_0 e^{-\lambda_A t}) e^{-\lambda_B t}$

$= N_0 e^{-\lambda_A t} + N_0 e^{-\lambda_B t} - N_0 e^{-(\lambda_A + \lambda_B) t} + N_0 - N_0 e^{-\lambda_A t} - N_0 e^{-\lambda_B t} + N_0 e^{-(\lambda_A + \lambda_B) t}$

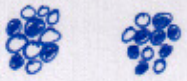
$= N_0$

$\frac{d}{dt}(N_A + N_B + N_C) = \frac{d}{dt} N_0 = 0$ □

c) $\lambda_{Se} = 4{,}3 \cdot 10^{-2} \frac{1}{s}$; $\lambda_{Br} = 1{,}3 \cdot 10^{-2} \frac{1}{s}$

$N_{Se}(t) = N_0 \cdot e^{-\lambda_{Se} t}$

$N_{Br}(t) = (N_0 - N_{Se}) e^{-\lambda_{Br} \cdot t} = (N_0 - N_0 \cdot e^{-\lambda_{Se} t}) e^{-\lambda_{Br} t}$

2) Spiegelkerne: 

$A = A$

$E_C = \frac{3\hbar c}{5\alpha}\frac{Z^2}{R}$ $\quad {}^{15}_{7}N\ ;\ {}^{15}_{8}O \Rightarrow Z_N = 7;\ Z_O = 8$

$\alpha = \frac{1}{137}$

$\Delta m = 2{,}754\ \frac{MeV}{c^2} = 4{,}9 \cdot 10^{-30}\ kg$

$R_N = R_O$

$\hookrightarrow \frac{1}{c^2}(E_{C,O} - E_{C,N}) = \Delta m = \frac{3\hbar c Z_O^2}{5\alpha R} - \frac{3\hbar c Z_N^2}{5\alpha R} = \Delta m \cdot c^2$

$\Rightarrow \frac{3\hbar c (Z_O^2 - Z_N^2)}{5\alpha \Delta m c^2} = R$

$R = \frac{3\hbar (64-49)\cdot 137}{5 \cdot 4{,}9 \cdot 10^{-30} kg \cdot 3 \cdot 10^8 \frac{m}{s}} = 8{,}85 \cdot 10^{-11} m = \underline{\underline{0{,}885\ Å}}$

3) Spaltung: $n + {}^{235}U \rightarrow {}^{92}Kr + {}^{142}Ba + 2n$

Fussion: ${}^{2}H + {}^{3}H \rightarrow {}^{4}He + n$

a)

$E_{Bind} = a_V \cdot A - a_0 \cdot A^{\frac{2}{3}} - a_C Z \cdot (Z-1) \cdot A^{-\frac{1}{3}} - a_S \cdot \frac{(N-Z)^2}{4A} + \begin{cases} +a_P \cdot A^{-\frac{1}{2}}, & gg\text{-Kern} \\ 0, & ug\ 1\ gu\text{-Kern} \\ -a_P \cdot A^{-\frac{1}{2}}, & uu\text{-Kern} \end{cases}$

$a_V = 15{,}67\ MeV$

$a_0 = 17{,}23\ MeV$

$a_C = 0{,}714\ MeV$

$a_S = 93{,}15\ MeV$

$a_P = 11{,}2\ MeV$

${}^{235}_{92}U$ (A oben, Z unten)

Neutronen # = 143 (ungerade)

Protonen # = 92 (gerade) $\Rightarrow$ ug-Kern

$\hookrightarrow E_{Bind} = 15{,}67\ MeV \cdot (235) - 17{,}23\ MeV \cdot (235)^{\frac{2}{3}} - 0{,}714\ MeV \cdot 92 \cdot (92-1) \cdot (235)^{-\frac{1}{3}}$

$- 93{,}15\ MeV \cdot \frac{(143-92)^2}{4 \cdot 235} + 0\ (ug\text{-Kern})$

$= 1799{,}9\ MeV$

$E_{Nuk} = \frac{E_{Bind}}{A} = \frac{1799{,}9\ MeV}{235} = \underline{\underline{7{,}66\ MeV}}$

b) $n + {}^{235}_{92}U \rightarrow {}^{92}_{36}Kr + {}^{141}_{56}Ba + 2n$

$\Delta m = m_n + m_U - m_{Kr} - m_{Ba} - 2m_n$

$= \frac{m_n}{u} + 235{,}04392\,u - 91{,}92615\,u - 141{,}91645\,u - \frac{2m_n}{u}$

$= 0{,}19266\,u$

$E_U = \Delta m\, c^2$

$= 2{,}87522 \cdot 10^{-11}\,J = \underline{\underline{179{,}45706\,MeV}}$

${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + n$

$\Delta m = m_{^2H} + m_{^3H} - m_{He} + \frac{m_n}{u}$

$= 2{,}01410\,u + 3{,}01605\,u - 4{,}00260\,u - \frac{m_n}{u}$

$= 0{,}01889\,u$

$E_H = \Delta m \cdot c^2$

$= 2{,}81844 \cdot 10^{-12}\,J = \underline{\underline{17{,}59134\,MeV}}$

c) $E_{1g\text{-}U} = m \cdot N_A \cdot E_U$

$= \frac{1\,g}{235\,\frac{g}{mol}} \cdot N_A \cdot 2{,}87522 \cdot 10^{-11}\,J = 7{,}36808 \cdot 10^{10}\,J$

$= \underline{\underline{20{,}46689 \cdot 10^3\,kWh}}$

$E_{1g(^2H,^3H)} = 1g\left(\frac{1}{2\frac{g}{mol}} + \frac{1}{3\frac{g}{mol}}\right) \cdot N_A \cdot E_H = 1{,}41442 \cdot 10^{12}\,J$

$= \underline{\underline{392{,}89458 \cdot 10^3\,kWh}}$

c) $E_C = E_K \qquad r: 10^{-14}\,m$

$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r} = \frac{3}{2}k_B T \Leftrightarrow T = \frac{e^2}{6\pi\varepsilon_0 r k_B} = \underline{\underline{1{,}114 \cdot 10^9\,K}}$

(Wiki sagt: $T \approx 100 \cdot 10^6\,K$)

4) $M(A,z) = C - \beta \cdot z + \gamma z^2 - \delta$ (Kern-Korrektur)

$\Leftrightarrow z^2 - \frac{\beta}{\gamma} z - \frac{\delta + C - M(A,z)}{\gamma} = 0$

$z_{1/2} = \frac{\beta}{2\gamma} \pm \sqrt{\frac{\beta^2}{4\gamma^2} + \frac{\delta - C + M(A,z)}{\gamma}}$

$C = A\left(\mu_n - a_n + \frac{a_n}{\sqrt[3]{A^2}} + a_0\right)$

$\beta = 2a_0 - \mu_n + \mu_p + m_e$

$\gamma \frac{4a_0}{A} + \frac{a_0}{\sqrt[3]{A}}$

$\delta = + \frac{a_p}{\sqrt{A}}$

$A = 74$, $M(A,z) = 74u \cdot \frac{c^2}{e} = 68930{,}6\,MeV$

$\mu_n = 939{,}6\,MeV$ $\quad a_n =$

$\mu_p = 938{,}3\,MeV$ $\quad a_0 =$

$m_e = 0{,}51\,MeV$ $\quad a_p =$

(hab leider Teile von meinem Script verloren...)

$z_1 = (\quad)\,MeV \Rightarrow z = \frac{z_1}{\mu_p} = (\quad) \quad z \in \mathbb{N}$

$z_2 = -(\quad)\,MeV$ (unphysikalisch)

Weiter ist zu zeigen:

$M(A,z) > M(A,z+1) \wedge M(A,z) > (A,z-1) + 2m_e$ □

5) $^{37}Cl + \nu_e \rightarrow {}^{37}A_1 + e^-$

$V = 400\,000\,l = 400\,m^3$

$\rho = 1\,\frac{g}{cm^3} = 1000\,\frac{kg}{m^3}$ $\quad m = \rho \cdot V' = 96\,920\,kg$

$\mathcal{R}$:= Reaktionsrate

$\mathcal{R} = \frac{1}{T_{1/2}} = 11{,}6 \cdot 10^{-6}\,\frac{1}{s}$

Isotopenanteil von $^{37}_{17}Cl$ beträgt 24,23% ($^{35}_{17}Cl \approx$ Rest)

$V' = 400\,m^3 \cdot 0{,}2423 = 96{,}92\,m^3$

$N_T = \frac{96920 \cdot 10^3\,g}{17\,\frac{g}{mol}} \cdot N_A = 3{,}43 \cdot 10^{27}$

$\sigma = 2{,}6 \cdot 10^{-45}\,cm^2 = 2{,}6 \cdot 10^{-41}\,m^2$

$\sigma = \frac{\mathcal{R}}{N_T \cdot \phi_\nu} \Leftrightarrow \phi_\nu = \frac{\mathcal{R}}{N_T \cdot \sigma} = \frac{11{,}6 \cdot 10^{-6}\,\frac{1}{s}}{3{,}43 \cdot 10^{27} \cdot 2{,}6 \cdot 10^{-41}\,m^2}$

$\phi_\nu = 130 \cdot 10^6\,\frac{1}{m^2 \cdot s} = 130 \cdot 10^{10}\,\frac{1}{cm^2 \cdot s}$

"Interessant" liegt so bei $6{,}5 \cdot 10^{10}\,\frac{1}{cm^2 s}$ ... ν_{eq}