Lösn. anv. till tentamen Fysik för E del II (2000-12-11)

1. Bragg: $2\frac{a}{\sqrt{h^2+k^2+l^2}}\sin\Theta = \lambda \Rightarrow \frac{\sin^2\Theta}{h^2+k^2+l^2} = \frac{\lambda^2}{4a^2}$

Ni: diamantstruktur: $h^2+k^2+l^2 = 3, 8, 11, 16, \ldots$
och $a = 5{,}43\,\text{Å}$

$\therefore \frac{\lambda^2}{4a^2} = \frac{\sin^2 15^\circ}{3} = \frac{\sin^2 24{,}5^\circ}{8} = \frac{\sin^2 29^\circ}{11} = \frac{\sin^2 36^\circ}{16} = 0{,}022$

$\Rightarrow \lambda = \sqrt{0{,}022}\cdot 2\cdot a = 1{,}61\,\text{Å}$; neutroner våglängd $= \lambda = \frac{h}{m_n v}$

a) $\Rightarrow v = \frac{h}{m_n \lambda} = \frac{6{,}63\cdot 10^{-34}}{1{,}67\cdot 10^{-27}\cdot 1{,}61\cdot 10^{-10}}\ \text{m/s} = 2464\ \text{m/s} \approx 2{,}5\cdot 10^3\ \text{m/s}$

b) 4:de reflexen för $h^2+k^2+l^2 = 16$ skall komma vid $\Theta = 80^\circ$

$\therefore 2\cdot\frac{5{,}43\,\text{Å}}{\sqrt{16}}\cdot\sin 80^\circ = \lambda \Rightarrow \lambda = 2{,}67\,\text{Å} \Rightarrow v = \frac{h}{m_n\cdot\lambda} = 1485\ \text{m/s} \approx 1{,}5\cdot 10^3\ \text{m/s}$

2. π^0-meson: i vila sönderfaller : $m_0c^2 = 67{,}5 + 67{,}5\ \text{MeV} = 135\ \text{MeV} = E_0$

π^0-meson: i rörelse sönderfaller : $v = ?$

$p = \frac{1}{c}\sqrt{E^2 - E_0^2}$

Energi: $E_1 \quad E_2 \quad E_3 = 99\ \text{MeV}$; $E_1 = E_2 + E_3$ ... (1)

Rörmängd: $\frac{1}{c}\sqrt{E_1^2 - E_0^2} \quad \frac{E_2}{c} \quad \frac{E_3}{c}$; $\sqrt{E_1^2 - E_0^2} = E_3 - E_2$ ... (2)

Kvadrera (1) och (2) och subtrahera: $E_0^2 = 4E_2E_3 \Rightarrow E_2 = \frac{E_0^2}{4E_3} = 46\ \text{MeV}$

Ekv. (1): $E_1 = E_2 + E_3 = 46\ \text{MeV} + 99\ \text{MeV} = 145\ \text{MeV}$

men $E_1 = \frac{E_0}{\sqrt{1 - v^2/c^2}}$

$\Rightarrow 1 - \frac{v^2}{c^2} = \left(\frac{E_0}{E_1}\right)^2 = \left(\frac{135}{145}\right)^2 \Rightarrow v = 0{,}36c$

3. $^{61}_{29}Cu \rightarrow {}^{61}_{28}Ni + e^+ + \nu$; $Q = [m^k_{Cu} - m^k_{Ni} - m_e]c^2 =$

$= [(60{,}933462u - 29m_e) - (60{,}931057u - 28m_e) - m_e]c^2 = 0{,}001307\,u\cdot c^2 = 1{,}217\ \text{MeV}$

Cu ⇒ Ni* + e^+ (E_{ke^+}) + ν (E_ν)

$E_{k,\text{rekyl}} \approx 0$

$E_{k,e^+\max}$ då $E_\nu \approx 0$; Vidare: $E_{k,Ni\ \text{rekyl}} \approx 0$ ty $m_e \ll m_{Ni}$

$\therefore E_{ke^+\max} \approx Q = 1{,}217\ \text{MeV}$ om Ni i grundtillstånd.

Svar: $E_{k,e^+\max} = 1{,}217 - 0{,}66 = 0{,}56\ \text{MeV}$ då Ni i exc. tillstånd