Parcial 27-FR2-2017

(1) T_{max} : corresp. a choque frontal en el CM

(a)

LAB: $\underset{V,P,T}{\overset{M}{\bullet\!\!\longrightarrow}}$ $\overset{m}{\bullet}$ $\xrightarrow[\substack{v=\beta \\ (c=1)}]{CM}$ (T Lorentz) $\overset{M\ P_{cm}}{\bullet\!\!\longrightarrow}\ \overset{m}{\longleftarrow\!\!\bullet}\ -P_{cm}$ choque CM $\overset{M}{\longleftarrow\!\!\bullet}\ \overset{m}{\bullet\!\!\longrightarrow}$ $-P_{cm}\quad P_{cm}$ vuelta al lab TL $-v=\beta$ $\overset{M\ T'_{min}}{\longrightarrow}\ \overset{m\ T'_{max}}{\bullet\!\!\longrightarrow}$

$T = T'_{min} + T'_{max}$

con $c=1$ $\quad E = mc^2 \rightarrow E = m$

$E = \sqrt{m^2c^4 + p^2c^2} \longrightarrow E = \sqrt{m^2 + p^2}$; TL al CM $\quad m \begin{cases} p' = -\gamma'\beta' m \\ e' = \gamma' m \end{cases}$ $v' > 0$ $\Rightarrow \frac{m\beta'}{\sqrt{1-\beta'^2}} = p_{cm}$ ó $\beta' = \frac{P_{cm}}{\sqrt{m^2 + P_{cm}^2}}$

Luego de la col. $m \begin{cases} p' = \gamma'\beta' m \\ e' = \gamma' m \end{cases} \Rightarrow E_{lab,m}^{\text{luego col}} = \gamma'(\gamma' m + \beta'^2\gamma' m) = m\gamma'^2(1+\beta'^2) = m\frac{1+\beta'^2}{1-\beta'^2} = m + \frac{2}{m}P_{cm}^2 \Rightarrow T'_{max} = \frac{2P_{cm}^2}{m}$

P_{cm}? (m, e)

(E,P) $\quad E = M\gamma = \frac{M}{\sqrt{1-v^2}}$, $P = \frac{MV}{\sqrt{1-v^2}} = EV$; en el CM luego de la col. $(E', -P_{cm})$ (e', P_{cm}) $\Rightarrow$ invariancia del 4-momento s^2

$\Rightarrow (E+m)^2 - P^2 = (e' + E')^2 \Rightarrow M^2 + m^2 + 2mM\gamma = M^2 + m^2 + 2P_{cm}^2 + 2\sqrt{M^2 + P_{cm}^2}\sqrt{m^2 + P_{cm}^2} \Rightarrow P_{cm}^2 = \frac{m^2M^2\beta^2\gamma^2}{m^2 + M^2 + 2mM\gamma}$

$\Rightarrow T'_{max} = \frac{2mM^2\beta^2\gamma^2}{m^2 + M^2 + 2mM\gamma} = \frac{2mT(T+2M)}{m^2 + M^2 + 2m(T+M)}$ $\cdot$ $T'_{max} \approx \frac{4m}{M}T \simeq 2m\beta^2 = 2mV^2$

$T \ll M \rightarrow \gamma \sim 1$

$m \ll M \quad \beta \sim 0$

(b)

(c) C1. $T = 70\,MeV$, $m = \frac{1}{2}\,MeV$, $M = 140\,MeV$

$T'_{max} = \frac{2\cdot\frac{1}{2}\cdot 70(70+280)}{\frac{1}{4} + 140^2 + 2\cdot\frac{1}{2}(70+140)} \simeq \frac{70^2\cdot 5}{70(3+280)} \sim \frac{35}{28}\,MeV$

$140 \gg T = 2\,MeV \quad T'_{max} = \frac{4\cdot\frac{1}{2}\cdot 2}{140} = \frac{1}{35}\,MeV$

C2. $m = M = \frac{1}{2}\,MeV$ $\quad T'_{max} = \frac{2mT(T+2m)}{m^2 + m^2 + 2m(T+m)} = \frac{T(T+2m)}{T+2m} = T$ (porque $m = M$!)

$T = T'_{max} = 0{,}15\,MeV,\ 150\,MeV$

(2) a) $S_c = \left.\frac{dT}{\rho\,dx}\right|_c = 2k\left(\ln 2m_ec^2 + \ln\frac{\beta^2}{1-\beta^2} - \beta^2 - \ln I\right) = 1{,}7\,(13.88 - \ln 9 - 0.1 - \ln 75) = 12.38$ $\boxed{\frac{MeV\,cm^2}{g}}$

(2.0, 4.32)

$2k = 4\pi r_0^2\ \frac{N_A Z}{A}\ \frac{z^2}{\beta^2}\ m_ec^2 = 99.8\times10^{-26}\,cm^2 \times 3{,}343\times10^{23}\ \frac{e}{g}\ \frac{z^2}{\beta^2}\ 0{,}51\,MeV = \frac{0.17\,z^2}{\beta^2}\ \frac{MeV\,cm^2}{g}$

b) $z = 1$ $\quad T = (\gamma-1)M = (\gamma-1)\,m\,\frac{M}{m} \Rightarrow T_M = \frac{M}{m_p}T_p = 51\ \frac{1875.6}{938.6} = \boxed{MeV\ 101{,}9}$

c) $S_M = S_p z^2$

$\alpha,\ z=2 \quad S_M = 4S_p = 49.6\ \frac{MeV\,cm^2}{g} \quad T_M = 202.6\ MeV$

$C,\ z=6 \quad S_M = 36\,S_p = 445{,}5$ " $\quad T_M = 638.6$ "

$N,\ z=10 \quad S_M = 100\,S_p = 1238$ " $\quad T_M = 1012$ "

(3) a) rad $\quad 10^4 \times 0{,}1 \times 0{,}4097 = 409.7\ MeV/cm^2$

col $\quad 10^4 \times 0{,}1 \times 2{,}063 = 2063\ MeV/cm^2$

$\rho = 1\,g/cm^3$ aprox. lineal ok porque son fracciones pequeñas

b) $S_{max} = 2.472\ MeV/g\,cm^3$

$S_{min} = 1{,}865\ MeV/g\,cm^3$ $\Rightarrow$ $R = \frac{1\times20}{1{,}865} = \boxed{10.72\,cm}$

$R = \frac{1\times20}{2.472} = \boxed{8.09\,cm}$