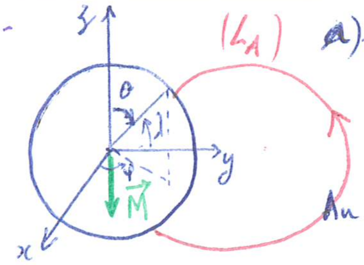
EM602-



a) $\vec B(r,\theta) = -\frac{\mu_0 M}{4\pi r^3}\left(2\cos\theta\,\vec u_r + \sin\theta\,\vec u_\theta\right)$

$\|\vec B\| = \frac{\mu_0 M}{4\pi r^3}\left(4\cos^2\theta + \sin^2\theta\right)^{1/2}$

Au pôle nord : $r = R_T$; $\theta = 0$ $\rightarrow$ $\|\vec B\| = B_0 = \frac{2\mu_0 M}{4\pi R_T^3}$

$\rightarrow M = \frac{4\pi R_T^3 B_0}{2\mu_0}$ $\qquad$ $M = 7{,}9.10^{22}\ Am^2$

b) Plan équatorial $\left(\theta = \frac{\pi}{2}\right)$: $\|\vec B\| = B_A = \frac{\mu_0 M}{4\pi r^3} = \frac{\mu_0 M}{4\pi R_T^3 \times 6^3} = \frac{1}{2\times 6^3} B_0 = \frac{B_0}{432}$

$\rightarrow B_A = 1{,}4.10^{-7}\,T$

c) $d\vec r = dr\,\vec u_r + r\,d\theta\,\vec u_\theta + r\sin\theta\,d\varphi\,\vec u_\varphi$

$\vec B = \frac{\mu_0 M}{4\pi r^3}\left(2\cos\theta\,\vec u_r + \sin\theta\,\vec u_\theta\right)$

Sur (L_A) $d\vec r \parallel \vec B$ $\Rightarrow$ $\begin{cases} dr = \alpha\, 2\cos\theta \\ d\theta = \frac{\alpha}{r}\sin\theta \end{cases}$ $\longrightarrow$ $\frac{dr}{d\theta} = r\,\frac{2\cos\theta}{\sin\theta}$

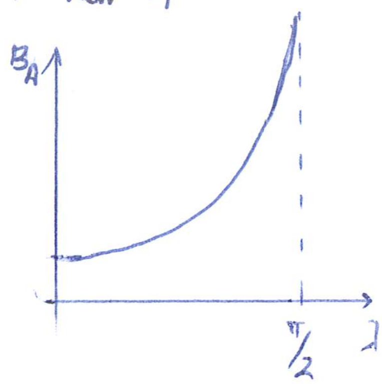
$\frac{dr}{r} = 2\,\frac{\cos\theta}{\sin\theta}\,d\theta$ $\longrightarrow$ $\ln r = 2\ln\sin\theta + Cte$

$r = Cte\,\sin^2\theta$

or $\lambda = \frac{\pi}{2} - \theta$ $\longrightarrow$ $r = Cte\,\cos^2\lambda$ $\quad$ passe par A $(r_A, \lambda = 0)$

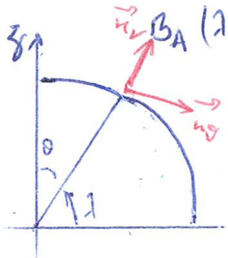
$\longrightarrow r = r_A\cos^2\lambda$

d) $\|\vec B_A\| = \frac{\mu_0 M}{4\pi r^3}\left(4\cos^2\theta + \sin^2\theta\right)^{1/2} = \overbrace{\frac{\mu_0 M}{4\pi r_A^3}}^{B_0/432}\frac{1}{\cos^6\lambda}\left(1 + 3\sin^2\lambda\right)^{1/2}$



e) $r = R_T = 6R_T\cos^2\lambda_0$ $\longrightarrow$ $\cos\lambda_0 = \frac{1}{\sqrt6}$

$\lambda_0 = \pm 66°$



$B_A(\lambda = 66°) = \frac{B_0}{2}\sqrt{\frac{21}{6}} = 0{,}94\,B_0 = 5{,}6\ 10^{-5}\,T.$

$B_H = B_\theta = -\frac{\mu_0 M}{4\pi R_T^3}\sin\theta = -\frac{\mu_0 M}{4\pi R_T^3}\cos\lambda$

$B_H = -\frac{B_0}{2}\cos\lambda_0$ $\qquad$ $|B_H| = 1{,}22\ 10^{-5}\,T$