2 SEVANJE OKROGLE TOKOVNE ZANKE

$$\vec{B}(\vec{r},t) = -\frac{\mu_0}{4\pi c_0 r}\,\frac{\vec{r}}{r}\times\frac{\partial}{\partial t}\int \vec{j}\left(\vec{r}\,',\ t-\frac{r}{c_0}+\frac{\vec{r}}{r}\cdot\frac{\vec{r}\,'}{c_0}\right) d^3\vec{r}\,'$$

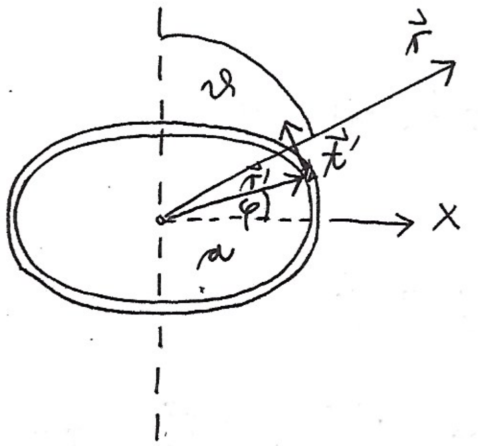
zanemaritev r' $\Rightarrow$ $\int \vec{j}(\vec{r}\,', t_r)\, d^3\vec{r}\,' = \underline{0}$ po poljubni ZANKI

↳ ne smemo zanemariti

$$\vec{j}\left(\vec{r}\,', t_r + \frac{\vec{r}}{r}\cdot\frac{\vec{r}\,'}{c_0}\right) \approx \vec{j}(\vec{r}\,', t_r) + \frac{\vec{r}\cdot\vec{r}\,'}{r c_0}\,\dot{\vec{j}}(\vec{r}\,', t_r) \quad \rightarrow \text{Taylor}$$

↳ integral vodi do $\underline{0}$!

$$\frac{\partial}{\partial t}\int \vec{j}\, d^3\vec{r}\,' \rightarrow \underline{\int \frac{\vec{r}\cdot\vec{r}\,'}{r c_0}\,\ddot{\vec{j}}(\vec{r}\,', t_r)\, d^3\vec{r}\,'}$$



$$\frac{\vec{r}}{r} = (\sin\vartheta, 0, \cos\vartheta)$$

$$\vec{r}\,' = a(\cos\varphi, \sin\varphi, 0)$$

$$\frac{\vec{r}\cdot\vec{r}\,'}{r c_0} = \frac{a}{c_0}\sin\vartheta\cos\varphi$$

$$d^3\vec{r}\,' = dS'\cdot a\, d\varphi$$

$$\int \vec{j}\, d^3\vec{r}\,' = \int_L I\,\vec{t}\,'\, a\, d\varphi$$

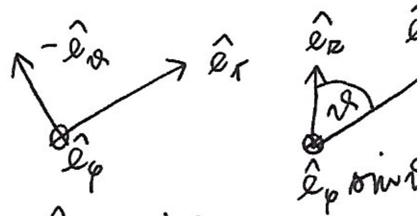
$$\vec{t}\,' = (-\sin\varphi, \cos\varphi, 0)$$

$$\int = \int_0^{2\pi}\frac{a^2\ddot{I}}{c_0}\underbrace{\sin\vartheta\cos\varphi\,(-\sin\varphi, \cos\varphi, 0)}_{\hat{e}_y \sin\vartheta \underbrace{\cos^2\varphi}_{\frac{1}{2}\cdot 2\pi = \pi} \text{ samo } \neq 0}\, d\varphi = \underbrace{\frac{\pi a^2\ddot{I}}{c_0}}_{\frac{\ddot{p}_m}{c_0}}\,\hat{e}_y \sin\vartheta$$

$\hat{e}_y \downarrow \hat{e}_\varphi$ v resnici

$$\vec{B}(\vec{r},t) = -\frac{\mu_0}{4\pi c_0^2 r}\,\hat{e}_r\times\hat{e}_\varphi \sin\vartheta\, \ddot{p}_m$$

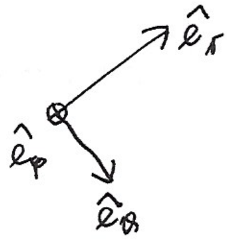
$$\vec{B}(\vec{r},t) = \frac{\mu_0}{4\pi c_0^2 r}\,\hat{e}_\vartheta \sin\vartheta\, \ddot{p}_m$$



$$\hat{e}_z\times\hat{e}_r = \hat{e}_\varphi \sin\vartheta$$

$$\vec{B}(\vec{r},t) = -\frac{\mu_0}{4\pi c_0^2 r}\hat{e}_r \times \underset{\ddot{p}_m}{(\hat{e}_R \times \hat{e}_r)\ddot{p}_m} = \frac{\mu_0}{4\pi c_0^2 r}\hat{e}_r \times (\hat{e}_r \times \ddot{p}_m)$$

$$\vec{E}(\vec{r},t) = -\hat{e}_r \times c_0 \vec{B} = -\frac{\mu_0}{4\pi c_0 r}\underbrace{\hat{e}_r \times \hat{e}_\vartheta}_{\hat{e}_\varphi} \sin\vartheta\, \ddot{p}_m$$



$$\vec{P} = \frac{1}{\mu_0}\vec{E}\times\vec{B} = \frac{\mu_0}{16\pi^2 c_0^3 r^2}\sin^2\vartheta\, \ddot{p}_m^2 \underbrace{(-\hat{e}_\varphi)\times \hat{e}_\vartheta}_{\hat{e}_r}$$

$$\vec{P} = \frac{\mu_0 \sin^2\vartheta\, \ddot{p}_m^2}{16\pi^2 c_0^3 r^2}\hat{e}_r \quad , \quad p_m = I_0 \pi a^2 \sin\omega t_r$$

$$\ddot{p}_m = -I_0 \pi a^2 \omega^2 \sin\omega t_r$$

$$\left\langle \int P\, dS \right\rangle = \int \frac{\mu_0 \sin^2\vartheta\, I_0^2 a^4 \omega^4}{32 c_0^3 r^2} r^2\, 2\pi\, d(\cos\vartheta) =$$

$$\int \sin^2\vartheta\, d(\cos\vartheta) = 2 - 2\cdot\frac{1}{3} = \frac{4}{3}$$

$$= \frac{\pi}{12}\frac{\overbrace{c_0\mu_0}^{Z_0} I_0^2 a^4\; 4\cdot 4\pi^4}{\lambda^4} = \frac{4\pi^5}{3} Z_0 I_0^2 \left(\frac{a}{\lambda}\right)^4 = \boxed{\frac{8\pi^5}{3} Z_0 I_{ef}^2 \left(\frac{a}{\lambda}\right)^4}$$