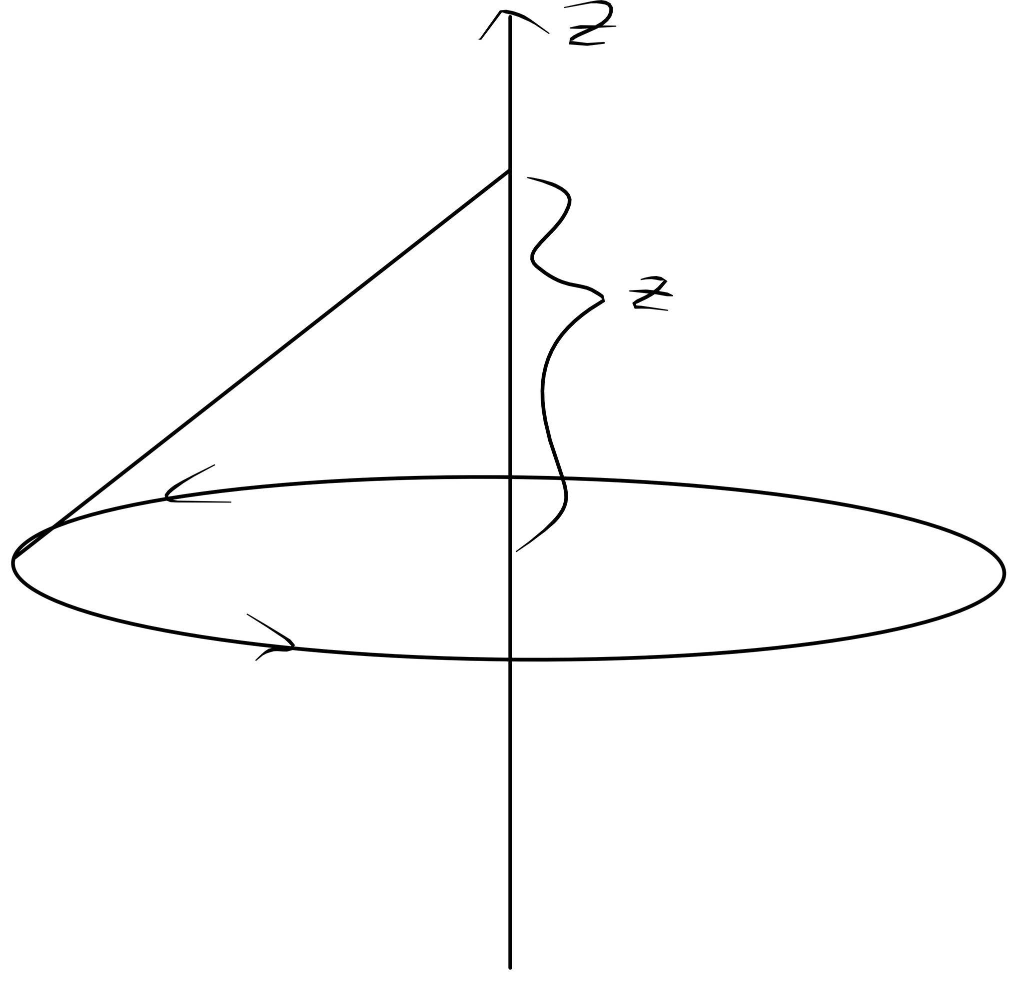
Od jednego obwodu:



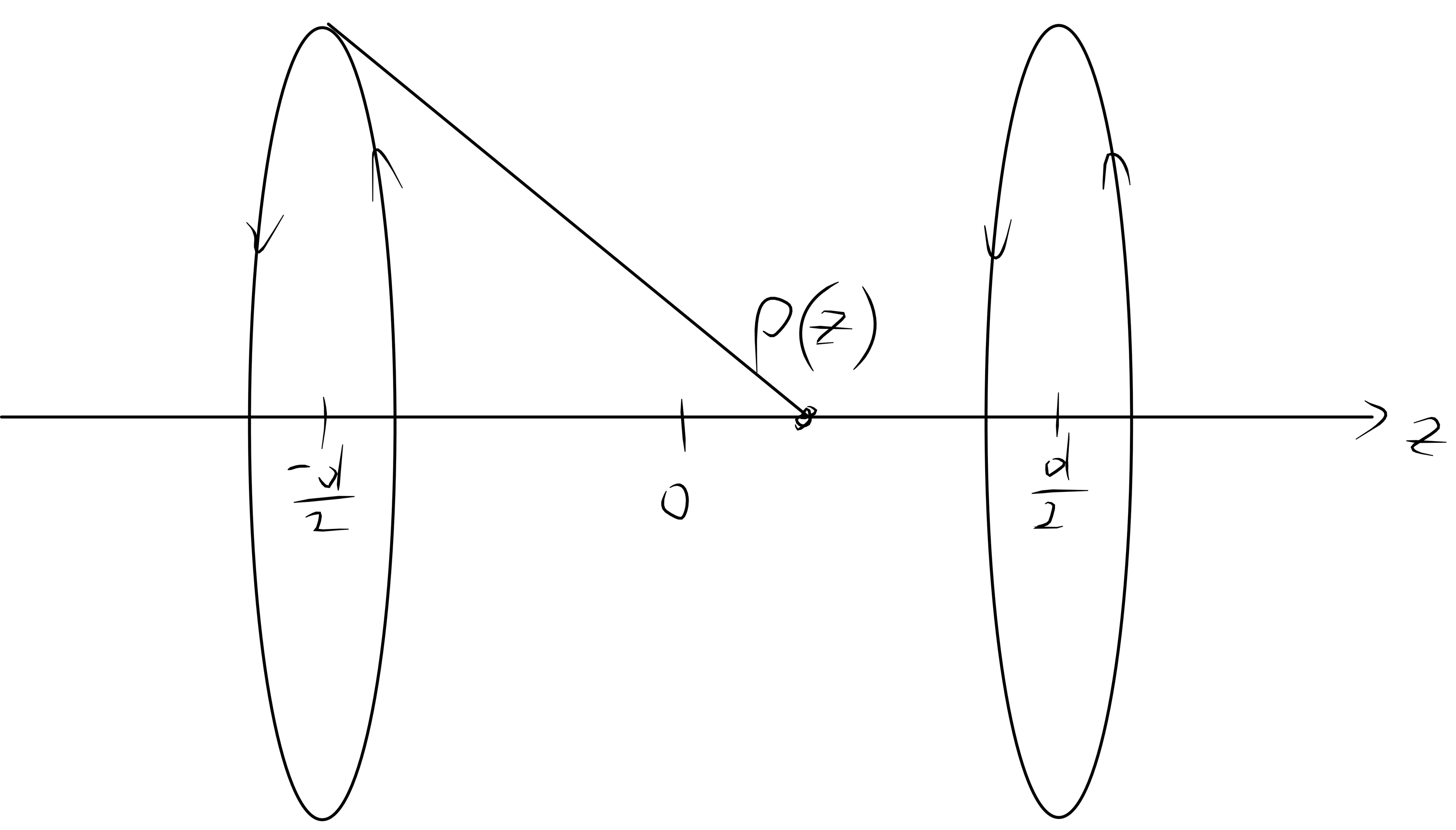
$$d\bar{B} = \frac{\mu_0 I}{4\pi}\frac{d\bar{l}\times\bar{r}}{(R^2+z^2)^2}$$

$$d\bar{l} = R\left[-\sin\varphi; \cos\varphi; 0\right]d\varphi$$

$$\bar{r} = \left[-R\cos\varphi; -R\sin\varphi; z\right]$$

$$dl\times\bar{r} = \left[R^2 z\cos\varphi; R^2 z\sin\varphi; R^2\right]d\varphi$$

$$\bar{B} = \frac{\mu_0 I}{4\pi}\int_0^{2\pi}\frac{\left[R^2 z\cos\varphi; R^2 z\sin\varphi; R^2\right]}{(R^2+z^2)^{\frac{3}{2}}}d\varphi = \frac{\mu_0 I R^2}{2(R^2+z^2)^{\frac{3}{2}}}\hat{e}_z$$



a)

$$\bar{B} = \bar{B}\left(z+\frac{d}{2}\right) + \bar{B}\left(z-\frac{d}{2}\right) = \frac{\mu_0 I R^2}{2}\hat{e}_z\left(\frac{1}{\left(R^2+\left(z+\frac{d}{2}\right)^2\right)^{\frac{3}{2}}} + \frac{1}{\left(R^2+\left(z-\frac{d}{2}\right)^2\right)^{\frac{3}{2}}}\right)$$

$$\frac{dB}{dz} = \frac{-\frac{3}{2}\,2\left(z+\frac{d}{2}\right)}{\left(R^2+\left(z+\frac{d}{2}\right)^2\right)^{\frac{5}{2}}} + \frac{-\frac{3}{2}\cdot 2\left(z-\frac{d}{2}\right)}{\left(R^2+\left(z-\frac{d}{2}\right)^2\right)^{\frac{5}{2}}} = -3\left[\frac{z+\frac{d}{2}}{\left(R^2+\left(z+\frac{d}{2}\right)^2\right)^{\frac{5}{2}}} + \frac{z-\frac{d}{2}}{\left(R^2+\left(z-\frac{d}{2}\right)^2\right)^{\frac{5}{2}}}\right]$$

$$\frac{dB}{dz}(0) = \frac{-3}{\left(R^2+\left(\frac{d}{2}\right)^2\right)^{\frac{5}{2}}}\left(\frac{d}{2}-\frac{d}{2}\right) = 0$$

b)

$$\frac{d^2B}{dz^2} = \frac{\left(R^2+\left(z+\frac{d}{2}\right)^2\right)^{\frac{5}{2}} + 5\left(z+\frac{d}{2}\right)^2\left(R^2+\left(z+\frac{d}{2}\right)^2\right)^{\frac{7}{2}}}{\left(R^2+\left(z+\frac{d}{2}\right)^2\right)^5} + \frac{\left(R^2+\left(z-\frac{d}{2}\right)^2\right)^{\frac{5}{2}} + 5\left(z-\frac{d}{2}\right)^2\left(R^2+\left(z-\frac{d}{2}\right)^2\right)^{\frac{7}{2}}}{\left(R^2+\left(z-\frac{d}{2}\right)^2\right)^5}$$

$$\frac{d^2B}{dz^2}(0) = 2\frac{\left(R^2+\left(\frac{d}{2}\right)^2\right)^{\frac{5}{2}} + 5\left(\frac{d}{2}\right)^2\left(R^2+\left(\frac{d}{2}\right)^2\right)^{\frac{7}{2}}}{\left(R^2+\left(\frac{d}{2}\right)^2\right)^5} = 0$$

dla $d\to\infty$, ponieważ licznik jest jak d^9, a mianownik jak d^{10}, wszystko jest dodatnie.

$$\lim_{d\to\infty} B(0) = 0$$

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