

$$\mu_0 \bar{I}_w = 2\pi j B$$

$$I_w = \int \bar{j} dS = \int_0^p \bar{j}_0 e^{-ap'} 2\pi p' dp' = 2\pi \bar{j}_0 \int_0^p p' e^{-ap'} dp' =$$

$$= 2\pi \bar{j}_0 \left[\frac{-p'}{a} e^{-ap'} - \frac{1}{a^2} e^{-ap'} \right]_0^p =$$

$$= 2\pi \bar{j}_0 \left[\frac{1}{a^2} - \frac{p}{a} e^{-ap} - \frac{1}{a^2} e^{-ap} \right]$$

$$= I \left[1 - ap e^{-ap} - e^{-ap} \right]$$

$$\begin{array}{l} 0 \\ + p' \\ - 1 \\ + 0 \end{array} \begin{array}{l} 1 \\ e^{-ap'} \\ - \frac{1}{a} e^{-ap'} \\ \frac{1}{a^2} e^{-ap} \end{array}$$

$$\bar{I} = \int_0^\infty \bar{j} dS = \frac{2\pi \bar{j}_0}{a^2}$$

$$B = \frac{\mu_0 \bar{I}}{2\pi} \left[\frac{1}{p} - ap e^{-ap} - \frac{1}{p} e^{-ap} \right] \approx \frac{\mu_0 \bar{I}}{2\pi} \left[\frac{1}{p} - a \left(1 - ap + \frac{a^2 p^2}{2} \right) - \frac{1}{p} \left(1 - ap + \frac{a^2 p^2}{2} \right) \right] =$$

$$= \frac{\mu_0 \bar{I}}{2\pi} \left[\cancel{\frac{1}{p}} - \cancel{a} + a^2 p - \frac{a^3 p^2}{2} - \cancel{\frac{1}{p}} + \cancel{a} - \frac{a^3 p^2}{2} \right] =$$

$$= \frac{\mu_0 \bar{I}}{2\pi} \frac{a^2 p}{2}$$

$$\frac{1}{a} \ll p$$

$$pa \rightarrow \infty$$

$$B(p) = \frac{\mu_0 \bar{I}}{2\pi p}$$

$$\frac{1}{a} \gg p$$

$$pa \rightarrow 0$$

$$B(p) = \frac{\mu_0 \bar{I}}{2\pi} \frac{a^2 p}{2}$$