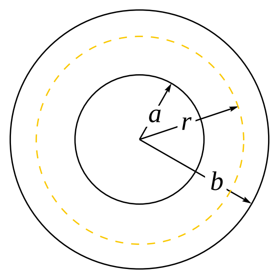
The thick pipe of current

(a.) *Qualitative considerations:* By symmetry, the magnitude of $\vec{B}$ can depend only upon the distance r from the cylinder axis. In addition, because $\vec{B}$ is the sum of many circular contributions all in the plane perpendicular to the cylinder axis, $\vec{B}$ must be in this plane. Finally, $\vec{B}$ must be tangent to circles around the axis because any radial component would lead to

$$\oint_{\text{surface}} \vec{B}\cdot\hat{n}\, dA \neq 0.$$

In summary, lines of $\vec{B}$ must be circles centered on the cylinder axis.



Quantitative considerations: For any circle centered on the axis,

$$\vec{B}\cdot d\vec{\ell} = B(r)\, d\ell \quad \text{and} \quad \oint \vec{B}\cdot d\vec{\ell} = B(r) \oint d\ell = B(r)\, 2\pi r$$

so, from Ampere's law,

$$B(r) = \frac{\mu_0 I_{\text{linked}}(r)}{2\pi r}.$$

Meanwhile:

For $r < a$, $I_{\text{linked}}(r) = 0$.

For $r > b$, $I_{\text{linked}}(r) = i$.

For $a < r < b$, $\dfrac{I_{\text{linked}}(r)}{i} = \dfrac{\text{area between } a \text{ and } r}{\text{area between } a \text{ and } b} = \dfrac{\pi(r^2 - a^2)}{\pi(b^2 - a^2)}$, whence $I_{\text{linked}}(r) = i\dfrac{(r^2 - a^2)}{(b^2 - a^2)}$.

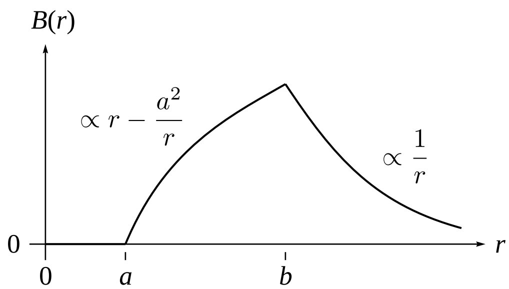
Thus

$$B(r) = \begin{cases} 0 & r < a \\ \dfrac{\mu_0 i}{2\pi r}\dfrac{(r^2 - a^2)}{(b^2 - a^2)} & a < r < b \\ \dfrac{\mu_0 i}{2\pi r} & b < r \end{cases}$$

(b.) $B(r)$ is continuous at $r = a$ and $r = b$: $B(a) = 0$ and $B(b)$ is appropriate for the $\vec{B}$ of a long thin wire, as expected.

If $a = 0$ this is the situation of LSM example 12.7 on page 536 (changing our b to LSM's a). And sure enough, if you plug $a = 0$, and change b to a into the equation above you come up with the equation at the bottom of page 536.

(c.)



The graphs of the left-most and right-most parts of the function are straightforward. For the middle portion ($a < r < b$) note that the slope is

$$\frac{dB}{dr} = \frac{\mu_0 i}{2\pi(b^2 - a^2)} \left(1 + 2\frac{a^2}{r^2}\right)$$

so that (i) the slope is always postive — never zero or negative — and (ii) as r increases, the slope decreases.