BAN Fri Jan 26 08:46:22 PST 2007

For a filament of radius $r = r_0$ at axial position $z = z_0$ with current I_0, the radial and axial magnetic flux densities are given by:

$$B_r(r,z) = \frac{\mu_0 I_0}{2\pi d}\frac{(z-z_0)}{r}\left[\frac{r^2+r_0^2+(z-z_0)^2}{(r-r_0)^2+(z-z_0)^2}E(m) - K(m)\right]$$

$$B_z(r,z) = \frac{\mu_0 I_0}{2\pi d}\left[K(m) - \frac{r^2-r_0^2+(z-z_0)^2}{(r-r_0)^2+(z-z_0)^2}E(m)\right]$$

and the poloidal flux is given by:

$$\psi(r,z) = \mu_0 I_0 d\left[\left(1-\frac{m}{2}\right)K(m) - E(m)\right]$$

where

$$d^2 = (z-z_0)^2 + (r+r_0)^2,$$

$$m = \frac{4rr_0}{d^2},$$

and $K(m)$ and $E(m)$ are the complete elliptic integrals of the first kind:

$$K(m) = \int_0^{\pi/2}\frac{d\varphi}{\left(1-m\sin^2\varphi\right)^{1/2}}$$

and the second kind:

$$E(m) = \int_0^{\pi/2}\left(1-m\sin^2\varphi\right)^{1/2}d\varphi.$$