The Emerging Flux Region Test Case

The field is constructed from the following components:

$$\boldsymbol{B} \quad = \quad \boldsymbol{e}_\phi B_\phi(r,\theta) + \boldsymbol{\nabla}\times[\boldsymbol{e}_\phi A(r,\theta)]$$

which has $\boldsymbol{\nabla}\cdot\boldsymbol{B} = 0$ by construction, but is *not* force-free. The particular choices for B_ϕ and A are:

$$\begin{aligned} B_\phi &= \frac{B_t}{r\sin\theta}\left[e^{-(r^2+R^2-2rR\sin\theta)/2a^2}\right. \\ &\quad \left. +\lambda\left(\frac{r^2+R^2-2rR\sin\theta}{\tilde{a}}\right)^2 e^{-(r^2+R^2-2rR\sin\theta)/2\tilde{a}^2}\cos n\psi\right] \\ A &= B_t q a\left[e^{-(r^2+R^2-2rR\sin\theta)/2a^2}\right. \\ &\quad \left. +\lambda\left(\frac{r^2+R^2-2rR\sin\theta}{\tilde{a}}\right)^2 e^{-(r^2+R^2-2rR\sin\theta)/2\tilde{a}^2}\cos n\psi\right] \end{aligned}$$

where $\tan\psi = (R - r\sin\theta)/r\cos\theta$.