bfield

Returns $\dot{s} \equiv B^s/B^\zeta$ and $\dot{\theta} \equiv B^\theta/B^\zeta$.

[called by: pp00ab.]

contents

1.1 equations of field line flow

1. The equations for the fieldlines are normalized to the toroidal field, i.e.

$$\dot{s} \equiv \frac{B^s}{B^\zeta}, \qquad \dot{\theta} \equiv \frac{B^\theta}{B^\zeta}. \tag{1}$$

1.2 representation of magnetic field

1. The components of the vector potential, $\mathbf{A} = A_\theta \nabla + A_\zeta \nabla\zeta$, are

$$A_\theta(s,\theta,\zeta) = \sum_{i,l} A_{\theta,e,i,l} \, \overline{T}_{l,i}(s)\cos\alpha_i + \sum_{i,l} A_{\theta,o,i,l} \, \overline{T}_{l,i}(s)\sin\alpha_i, \tag{2}$$

$$A_\zeta(s,\theta,\zeta) = \sum_{i,l} A_{\zeta,e,i,l} \, \overline{T}_{l,i}(s)\cos\alpha_i + \sum_{i,l} A_{\zeta,o,i,l} \, \overline{T}_{l,i}(s)\sin\alpha_i, \tag{3}$$

where $\overline{T}_{l,i}(s) \equiv \bar{s}^{m_i/2} T_l(s)$, $T_l(s)$ is the Chebyshev polynomial, and $\alpha_j \equiv m_j\theta - n_j\zeta$. The regularity factor, $\bar{s}^{m_i/2}$, where $\bar{s} \equiv (1+s)/2$, is only included if there is a coordinate singularity in the domain (i.e. only in the innermost volume, and only in cylindrical and toroidal geometry.)

2. The magnetic field, $\sqrt{g}\,\mathbf{B} = \sqrt{g}B^s\mathbf{e}_s + \sqrt{g}B^\theta\mathbf{e}_\theta + \sqrt{g}B^\zeta\mathbf{e}_\zeta$, is

$$
\begin{aligned}
\sqrt{g}\,\mathbf{B} = \ &\mathbf{e}_s &&\sum_{i,l}[(&&-m_i A_{\zeta,e,i,l} &&- &&n_i A_{\theta,e,i,l} &&)\overline{T}_{l,i}\sin\alpha_i + (&&+m_i A_{\zeta,o,i,l} &&+ &&n_i A_{\theta,o,i,l} &&)\overline{T}_{l,i}\cos\alpha_i] \\
+\ &\mathbf{e}_\theta &&\sum_{i,l}[(&& && - &&A_{\zeta,e,i,l} &&)\overline{T}'_{l,i}\cos\alpha_i + (&& && - &&A_{\zeta,o,i,l} &&)\overline{T}'_{l,i}\sin\alpha_i] \\
+\ &\mathbf{e}_\zeta &&\sum_{i,l}[(&&A_{\theta,e,i,l} && && &&)\overline{T}'_{l,i}\cos\alpha_i + (&&A_{\theta,o,i,l} && && &&)\overline{T}'_{l,i}\sin\alpha_i]
\end{aligned}
\tag{4}
$$

3. In Eqn.(1), the coordinate Jacobian, $\sqrt{g}$, cancels. No coordinate metric information is required to construct the fieldline equations from the magnetic vector potential.