bfield

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

[called by: pp00ab.]

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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

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

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.