

**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.

$$\dot{s} \equiv \frac{B^s}{B^\zeta}, \quad \dot{\theta} \equiv \frac{B^\theta}{B^\zeta}. \quad (1)$$

**1.2 representation of magnetic field**

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

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

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

where  $\bar{T}_{l,i}(s) \equiv \bar{s}^{m_i/2} T_l(s)$ ,  $T_l(s)$  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

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

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.