bf00aa

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

[called by: pp00ab.]

contents

1 bf00aa **1**

1.1 equations of field line flow . . . 1

1.2 plasma region . . . 1

1.2.1 coordinate singularity . . . 1

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 plasma region

1. The magnetic field in the plasma region is

$$\mathbf{B} = \nabla \times \left(A_\theta \nabla\theta + A_\zeta \nabla\zeta \right), \tag{2}$$

from which we obtain the contravariant components of the magnetic field directly:

$$\begin{array}{lllllll} B^s & = & (& \partial_\theta A_\zeta & - & \partial_\zeta A_\theta &) \;/\; \sqrt{g}, \\ B^\theta & = & (& & - & \partial_s A_\zeta &) \;/\; \sqrt{g}, \\ B^\zeta & = & (& \partial_s A_\theta & & &) \;/\; \sqrt{g}. \end{array} \tag{3}$$

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

3. The components of the vector potential are

$$A_\theta(s,\theta,\zeta) = \sum_{j,l} A_{\theta,e,j,l}\, T_l(s) \cos\alpha_j + \sum_{j,l} A_{\theta,o,j,l}\, T_l(s) \sin\alpha_j, \tag{4}$$

$$A_\zeta(s,\theta,\zeta) = \sum_{j,l} A_{\zeta,e,j,l}\, T_l(s) \cos\alpha_j + \sum_{j,l} A_{\zeta,o,j,l}\, T_l(s) \sin\alpha_j, \tag{5}$$

where $\alpha_j \equiv m_j\theta - n_j\zeta$.

4. Note that in each volume $s \in [-1,1]$, and $T_l(s)$ are the Chebyshev polynomials.

1.2.1 coordinate singularity

1. In the innermost region, regularity factors are included. Introduce $\bar{s} \equiv (s+1)/2$, so that $\bar{s} \in [0,1]$. The magnetic vector potential is described by

$$A_\theta(s,\theta,\zeta) = \sum_{j,l} A_{\theta,e,j,l}\, \bar{s}^{m_j/2}\, T_l(s) \cos\alpha_j + \sum_{j,l} A_{\theta,o,j,l}\, \bar{s}^{m_j/2}\, T_l(s) \sin\alpha_j, \tag{6}$$

$$A_\zeta(s,\theta,\zeta) = \sum_{j,l} A_{\zeta,e,j,l}\, \bar{s}^{m_j/2}\, T_l(s) \cos\alpha_j + \sum_{j,l} A_{\zeta,o,j,l}\, \bar{s}^{m_j/2}\, T_l(s) \sin\alpha_j. \tag{7}$$