sc00aa

The covariant components of the tangential magnetic field are related to the singular currents at the interfaces.

[called by: xspech.] [calls: coords.]

contents

1.1 covariant representation

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

$$A_\theta(s,\theta,\zeta) = \sum_{i,l} A_{\theta,e,i,l}\, \overline{T}_{l,i}(s)\cos\alpha_i + \sum_{i,l} A_{\theta,o,i,l}\, \overline{T}_{l,i}(s)\sin\alpha_i, \tag{1}$$

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

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

$$\begin{array}{ccllllllllll} \sqrt{g}\,\mathbf{B} & = & \mathbf{e}_s & \sum_{i,l}[(& -m_i A_{\zeta,e,i,l} & - & n_i A_{\theta,e,i,l} &)\overline{T}_{l,i}\sin\alpha_i + (& +m_i A_{\zeta,o,i,l} & + & n_i A_{\theta,o,i,l} &)\overline{T}_{l,i}\cos\alpha_i] \\ & + & \mathbf{e}_\theta & \sum_{i,l}[(& & - & A_{\zeta,e,i,l} &)\overline{T}'_{l,i}\cos\alpha_i + (& & - & A_{\zeta,o,i,l} &)\overline{T}'_{l,i}\sin\alpha_i] \\ & + & \mathbf{e}_\zeta & \sum_{i,l}[(& A_{\theta,e,i,l} & & &)\overline{T}'_{l,i}\cos\alpha_i + (& A_{\theta,o,i,l} & & &)\overline{T}'_{l,i}\sin\alpha_i] \end{array} \tag{3}$$

3. The covariant representation for the field is $\mathbf{B} = B_s\nabla s + B_\theta\nabla\theta + B_\zeta\nabla\zeta$, where

$$\begin{aligned} B_s &= B^s g_{ss} + B^\theta g_{s\theta} + B^\zeta g_{s\zeta} \\ B_\theta &= B^s g_{s\theta} + B^\theta g_{\theta\theta} + B^\zeta g_{\theta\zeta} \\ B_\zeta &= B^s g_{s\zeta} + B^\theta g_{\theta\zeta} + B^\zeta g_{\zeta\zeta} \end{aligned}$$

where $g_{\alpha\beta}$ are the metric elements (computed by coords).

4. On the interfaces, $B^s = 0$ by construction.

1.2 output data

1. The Fourier harmonics of the even-and-odd, covariant components of the magnetic field, B_s, B_θ and B_ζ, are saved in

```
Btemn(1:mn,0:1,1:Mvol),
Bzemn(1:mn,0:1,1:Mvol),
Btomn(1:mn,0:1,1:Mvol),
Bzomn(1:mn,0:1,1:Mvol);
```

and these are written to `ext.sp.h5` by hdfint.