packxi

Packs, and unpacks, geometrical degrees of freedom; and sets coordinate axis.

[called by: dforce, global, hesian, newton and xspech.] [calls: rzaxis.]

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1.1 geometrical degrees of freedom

- 1. The geometrical degrees-of-freedom, namely the $R_{j,v}$ and $Z_{j,v}$ where v labels the interface and j labels the Fourier harmonic, must be "packxi", and "unpackxi", into a single vector, $\boldsymbol{\xi}$, so that standard numerical routines can be called to find solutions to force-balance, i.e. $\mathbf{F}[\boldsymbol{\xi}] = 0$.
- 2. A coordinate "pre-conditioning" factor is included:

$$\boldsymbol{\xi}_k \equiv \frac{R_{j,v}}{\Psi_{j,v}},\tag{1}$$

where $\Psi_{j,v} \equiv psifactor(j,v)$, which is defined in global.

1.2 coordinate axis

- 1. The coordinate axis is not an independent degree-of-freedom of the geometry. It is constructed by extrapolating the geometry of the innermost interface down to a line.
- 2. Note that if the coordinate axis depends only on the geometry of the innermost interface then the block tridiagonal structure of the the force-derivative matrix is preserved.
- 3. Define the arc-length weighted averages,

$$R_0(\zeta) \equiv \frac{\int_0^{2\pi} R_1(\theta, \zeta) dl}{L(\zeta)}, \qquad Z_0(\zeta) \equiv \frac{\int_0^{2\pi} Z_1(\theta, \zeta) dl}{L(\zeta)}, \tag{2}$$

where $L(\zeta) \equiv \int_0^{2\pi} dl$ and $dl \equiv \sqrt{\partial_{\theta} R_1(\theta, \zeta)^2 + \partial_{\theta} Z_1(\theta, \zeta)^2} d\theta$.

- 4. Note that if dl does not depend on θ , i.e. if θ is the equal arc-length angle, then the expressions simplify.
- 5. Note that the geometry of the coordinate axis thus constructed only depends on the geometry of the innermost interface, by which I mean that the geometry of the coordinate axis is independent of the angle parameterization.

1.3 some numerical comments

- 1. First, the differential poloidal length, $dl \equiv \sqrt{R_{\theta}^2 + Z_{\theta}^2}$, is computed in real space using an inverse FFT the from Fourier harmonics of R and Z.
- 2. Second, the Fourier harmonics of the dl are computed using an FFT. The integration over θ to construct $L \equiv \int dl$ is now trivial: just multiply the m = 0 harmonics of dl by 2π . The ajk(1:mn) variable is used.
- 3. Next, the weighted Rdl and Zdl are computed in real space, and the poloidal integral is similarly taken.
- 4. Lastly, the Fourier harmonics are constructed using an FFT after dividing in real space.

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SPEC subroutines;