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TH/7-2: Non-Axisymmetric Equilibrium Reconstruction for Stellarators,Reversed Field Pinches and Tokamaks

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Equilibrium reconstruction is the process of minimizing the mismatch between modeled and observed signals by changing the parameters that specify the equilibrium. While stellarator equilibria are inherently non-axisymmetric, non-axisymmetric effects are also crucial for understanding stability and confinement of high-performance reversed field pinch and tokamak plasmas. Therefore, two-dimensional reconstruction tools are not adequate for fully exploring 3D plasmas.
The V3FIT and STELLOPT codes are 3D equilibrium reconstruction codes, both based on the VMEC 3D equilibrium code. VMEC models field-period symmetric 3D flux surface geometry but does not treat magnetic islands and chaotic regions. VMEC requires the specification of the pressure and either rotational transform or toroidal current profiles, as functions of either the toroidal or poloidal flux. VMEC can treat both axisymmetric and non-axisymmetric configurations, both free- and fixed-boundary equilibria, and both stellarator-symmetric and non-stellarator-symmetric equilibria.
Both V3FIT and STELLOPT can utilize signals from magnetic diagnostics, soft X-rays (SXR), Thomson scattering, and geometrical information from plasma limiters. STELLOPT can also utilize Motional Stark Effect (MSE) signals. Both calculate a finite difference approximation to a Jacobian for the signal-mismatch minimization. V3FIT and STELLOPT differ in the details of their minimization algorithms, their utilization of auxiliary profiles (like electron density and soft x-ray emissivity), and in their computation of model signals.
V3FIT is currently in use on stellarators (HSX, CTH), reversed field pinches (RFX-mod) and tokamaks (DIII-D) for a wide variety of studies: interpretation of Pfirsch-Schlüter and bootstrap currents, design of new magnetic diagnostics, magnetic island generation, vertical instabilities, density-limit disruption activity, conformance of multiple data sources to a single set of flux surfaces, quasi-single helicity states in reversed field pinches, and error-field effects on nominally axisymmetric tokamak plasmas. STELLOPT is currently in use on stellarators (LHD) and tokamaks (DIII-D) providing detailed profile reconstructions for transport calculations and diagnostic inversions. Examples of equilibrium reconstruction are shown.

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