Instructions for GIST

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I Introduction

Purpose of the code Gist (Geometry Interface for Stellarators and Tokamaks) is the generation of the geometric information necessary for gyrokinetic simulations. Gist is able to produce two types of field-aligned coordinate systems:

1. The Boozer coordinate system $\{\sqrt{s}, \alpha, \theta\}$, where $\alpha = \frac{\sqrt{s_0}}{q_0}(q\theta - \zeta)$. Here, θ, ζ are the Boozer poloidal and toroidal angles, respectively.

2. The PEST coordinate system $\{\sqrt{s}, \alpha, \theta^*\}$, where $\alpha = \frac{\sqrt{s_0}}{q_0}(q\theta^* - \phi)$. Here, the poloidal angle θ^* is derived from the corresponding VMEC angle and ϕ is the cylindrical toroidal angle.

For both systems above, s denotes the normalized toroidal magnetic flux, and the subscript "0" denotes flux quantities on a surface (i.e., constants).

Starting point for both approaches is a **VMEC** equilibrium calculation (at present Gist supports VMEC v. 8.47, 8.46, 8.00 and 6.90), and we assume that the user is already equipped with a corresponding wout.txt (not wout.nc) file. For most tokamak applications it is customary that **EFIT** files are present (contrary to VMEC). Then, Gist is able to process a typical EFIT file in order to produce the geometry based on the PEST coordinate system (but not the Boozer).

Gist is able to create the geometry either for a single magnetic line or an entire magnetic surface covered by an ensemble of magnetic lines. While Gist is primarily designed to support the gyrokinetic code GENE, there exists also interface to the GS2 code. For the latter, only the Boozer coordinate setup is available.

II Installation

Prerequisites for the installation are: a) a 64bit platform and b) the ifort (Intel) compiler. In case the user has only access to a 32bit machine and/or another compiler is present, they should contact the author. In order to compile Gist, go to */home/GIST/src/* and give *make*.

III Running GIST for GENE

The user should first decide upon using Boozer or PEST coordinates. This is accomplished by modifying the relevant flags in the namelist *coordinates* found in the GIST input file *gist.inp* (in */home/GIST/inp/*).

The parameters found in the namelist *in_out* are:

- *global_y (logical)*: If .t., the geometry for an entire or partial (in view of symmetry, see below) selected magnetic surface is generated, to be used in tandem with the **full-surface** GENE code. If .f., the geometry for a single magnetic line is generated, to be used with the **local** GENE code.

- *vmec_dir (string)*: The directory where the VMEC file resides.

- *vmec_file (string)*: The name of the VMEC file; it will be appended to the GIST output file name (it is thus recommended to keep VMEC file names short).

- *out_tag (string)*: A user defined tag for specific information (e.g., radial location of the surface). This tag is also appended to the output file name.

In the namelist *setup*, the parameters found are:

- *s0 (real)*: Determines the radial location of the surface in terms of the normalized toroidal flux.

- *alpha0 (real)* *only for global_y=.f.*: Field line label to select a specific field line.

- *alpha0_start (real)* *only for global_y=.t.*: Starting value of alpha0. Here, one should take advantage of the stellarator symmetry. For instance, for W7X, which is characterized by a five-fold symmetry, the natural choice would be -0.6283 ($= -\pi/5$).

- *alpha0_end (real)* *only for global_y=.t.*: End value of alpha0. In the previous example, the value would be 0.6283.

- *nalpha0 (integer)* *Only for global_y=.t.*: Number of lines covering the surface (corresponds to the GENE parameter *nky0*).

- *pol_turns (real)*: The number of poloidal transits covered (default=1.).

- *nz0 (integer)*: Determines the resolution in the parallel direction (corresponds to the GENE parameter *nz0*).

To execute GIST, in the directory */home/GIST/bin/* give *./gist*. After successful operation, the following output files appear in */home/GIST/out/*: *gist_genet_* plus name tags for the tube or *gist_geney_* plus name tags for the full-surface mode of operation. The PEST coordinate file is identified by the tag *pest*, whereas for Boozer coordinates the tag *boozer* is found instead.

IV Running GIST for GS2

The namelist *coordinates* is not relevant, as only Boozer coordinates are availabe for this code.

Before using a VMEC file for the first time, modify the *in_out* namelist, so that *initialize=.t.* appears. This will result in the equilibrium transformation from VMEC to Boozer coordinates. However, for creating another GIST file for an already initialized equilibrium, this (time-consuming) step is no longer necessary, thus *initialize=.f.* should be set.

Other relevant parameters in the namelist *in_out* are:

- *gs2 (logical)*: This must equal .t. for GS2 operation.
- *vmec_dir (string)*: The directory where the VMEC file resides.
- *vmec_file (string)*: The name of the VMEC file; it will be appended to the output file name (it is thus recommended to keep VMEC file names short).
- *out_tag (string)*: A user defined tag, for specific information. This tag is appended to the output file name.
- *vmec_6_90 (logical)*: It must be set to .t. if one uses this specific VMEC version.

In the namelist *setup*, the parameters found are:

- *surf (integer)*: Determines the flux surface in which the flux tube will reside, via $s = (\mathrm{surf} + 0.5)/(N_s - 1)$, where N_s is the total number of VMEC surfaces. This number appears in the header of the VMEC file, next to the number of periods (e.g., if this number is 49, then surf=25 corresponds roughly to the midradius).
- *alpha0 (real)*: Field line label to select a specific field line.
- *pol_turns (real)*: The number of poloidal transits covered.
- *nz0 (integer)*: Determines the resolution in the parallel direction. The total number of points will be $2 * nz0 + 1$.

To execute GIST, in the directory */home/GIST/bin/* give *./gist*. After successful operation, the following output file will appear in */home/GIST/out/*: *gist_gs2_* plus name tags.