SCEPTIC3D's postprocessing using Matlab

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1 readoutput.m

Introduction

The fundamental Matlab script for reading SCEPTIC3D output files (i.e. .dat) is "readoutput.m", whose purpose is to parse the output file named "filename", and store all relevant data in Matlab variables. Because it is a script it takes no argument, but needs the following 2 booleans to be defined:

- short: If the boolean variable "short" is true, grid variables (such as potential, density, ...) are not read for time saving purposes, else they are.
- readforce: If short=false and the boolean variable "readforce" is true, force outputs are read, else they are not.

Example of readouput call from the Matlab Console

The following sequence will parse "./../outputs/T1e0v020a00r12P08L3e0.dat" (put here the location of your own .dat file).

```
>> short = false;
>> readforce = false;
>> filename = './../outputs/T1e0v020a00r12P08L3e0.dat';
>> readoutput;
```

The Matlab command "whos" allows to see the data that has been created, that can now be used. For example if one wants to plot the number of computational ions striking the probe per time-step (very useful to check if the run has converged), we can type:

```
>> plot(fluxprobe);
```

Unless a new unexisting diagnostic is needed however, the user does not need to directly use this raw data. Several postprocessing routines calling "readoutput.m" and performing the appropriate treatment and plotting are available.

2 Single-run postprocessing

Postproc.m

The “Postproc” function takes “filename” as argument, and plots the average angular ion flux distribution as a function of $\cos\chi$, where χ is here the angle along the drift axis. In the absence of magnetic field this plot is independent of the angle between v_d and e_z.

Also plotted is the average potential at $r = 1$ (still as a function of χ). In finite Debye length runs this is merely the probe potential, but if the Debye length is exactly zero it is then the “sheath entrance potential”, i.e. the potential at the radial distance where the quasi-neutral equations break-down, geometrically located at $r = 1$.

This function has been used, for instance, to produce Fig. (4) in Ref. [1].

2.1 PostprocSphere.m

PostprocSphere takes “filename” as argument, and creates a colour plot of the collected ion-flux density. Beware that in this function the flux is normalized to $N_\infty c_{sI}$ rather than Γ_i^0 in the other functions.

This function has been used, for instance, to produce Fig. (12) in Ref. [1].

2.2 Contouring

Different contouring functions, taking “filename” as arguments, exist:

- RhoPlotPsi0.m: Contours the normalized ion charge density at $\psi = 0$, i.e. on the $x - z$ plane.
- RhoPlotPsiPio2.m: Contours the normalized ion charge density at $\psi = \pi/2$, i.e. on the $y - z$ plane.
- RhoPlotThPio2.m: Contours the normalized ion charge density at $\theta = \pi/2$, i.e. on the $x - y$ plane.

PhiPlotPsi0.m, PhiPlotPsiPio2.m and PhiPlotThPio2.m do the same for the normalized potential ϕ. TPlotPsi0.m, TPlotPsiPio2.m and TPlotThPio2.m do the same for the normalized ion temperature tensor $\bar{\bar{T}}_i$.

Those functions have been used, for instance, to produce Figs (5,7,8) in Ref. [1], or Fig.(7) in Ref. [2]

3 Multi-run postprocessing

3.1 “titles” bash script

In addition to parsing output files one at a time, it can be useful to postprocess a series of output files having all the same properties except one. For this purpose, we can run the “titles” bash script in any folder containing a series of such output files, which will create a text file will the list of output files in that same folder.

For example, running $ titles myrunlist
on the linux console will create a textfile called “myrunlinst”.

3.2 PostprocB.m

PostprocB takes “myrunlist” as argument. It will plot the total ion current to the sphere versus magnetic field for all files in “myrunlist”. Of course this is useful only if all those files differ only by the magnetic field. It is easy for the user to modify this routine in order, for example, to plot current versus Debye length, or whatever is needed.

This function has been used, for instance, to produce Fig. (11) in Ref. [2].

3.3 PostprocForceB.m

PostprocForceB plots the ion-drag force along 3 axis, in addition to the external forces. The first argument is “myrunlist”. The second is “cart”, when true the forces are plotted along x,y,z, when false along B, $B^{\perp}$. The third is“Tiunits”, when true the forces are output in ion thermal units, when false in electron thermal units. The fourth is “outer”, when true the forces computed both at the inner and outer boundary are plotted, when false only the forces computed at the inner boundary are plotted.

This function has been used, for instance, to produce the following figures in Ref. [3]: Fig. (2) with Tiunits=true, Fig. (3) with outer=true.

References

[1] L. Patacchini and I.H. Hutchinson, *Spherical probes at ion saturation in* $\mathbf{E}\times\mathbf{B}$ *fields*, Plasma Phys. Control. Fusion **52**, 035005 (2010).

[2] L. Patacchini and I.H. Hutchinson, *Spherical conducting probes in finite Debye length plasmas and* $\mathbf{E}\times\mathbf{B}$ *fields*, Plasma Phys. Control. Fusion **53**, 025005 (2011).

[3] L. Patacchini and I.H. Hutchinson, *Forces on a spherical conducting particle in* $\mathbf{E}\times\mathbf{B}$ *fields*, Plasma Phys. Control. Fusion **??**, ?? (2011).