Readme

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Supplementary data for a study of microtearing modes at low plasma β

This repository contains `GS2` input files for sections 4 and 5 of the paper "*New linear stability parameter to describe low-β electromagnetic microinstabilities driven by passing electrons in axisymmetric toroidal geometry,* M. R. Hardman, F. I. Parra, B. S. Patel, C. M. Roach, J. Ruiz Ruiz, M. Barnes, D. Dickinson, W. Dorland, J. F. Parisi, D. St-Onge, and H. Wilson, Plasma Phys. Control. Fusion, arXiv:2208.10615"

Supplementary information

The files in this repository are contained within the zip folder `supplementary_data`. The files used to create this readme are within the subfolder `../readme`.

All gyrokinetic simulations in the study were performed using the gyrokinetic code `GS2`, found at `https://bitbucket.org/gyrokinetics/workspace/projects/GS2`. The simulations presented in this work used the branch `https://bitbucket.org/gyrokinetics/gs2/branch/ms_pgelres`, with the commit `ade578037218496bd9d328a55212e4f0add7529f`. The `Makefiles` and `utils` subdirectories are stored in the separate git repositories `makefiles` and `utils` found in `https://bitbucket.org/gyrokinetics/`, respectively. The branches used are `ms_makefiles` and `ms_utils`, at `5883dc35891514973bf3fbeedc003c2db3f23ac0` and `f59923440dbfea522f84f233c6fe2c0aec37fa6b`, respectively.

`GS2` input files for the simulations used in this study are contained in the subfolder

`../input_files/data_by_figure/ .`

The input files are organised according to the figures presented. For example, subfolders are

`../input_files/data_by_figure/figure-2 ,`
`../input_files/data_by_figure/figure-4-5-6-7-8 ,`

etc. Some input files are duplicated where data is used from the same simulation in multiple figures.

The names of the input files are structured to give information pertinant to the parameter scan carried out. In this study, it is important to to know the binormal wavenumber k_y, the

mass ratio $\sqrt{m_e/m_i}$, and β values. For figures 2-12, we scan in k_y at fixed mass and β, and at fixed k_y with $\sqrt{m_e/m_i} \propto \beta$.

The structure of the input file names for figures 2-12 have the form:

`rootname.ky.K.meN.in`,

where `rootname` is a string, `K` is a number referring the binormal wavenumber `K` in the `kt_grids` namelist. For example,

```
&kt_grids_range_parameters
    ntheta0 = 6
    theta0_min = 0.0
    theta0_max = 3.1415
    naky = 1
    aky_min = K
    aky_max = K
/
```

The integer `N` refers to the electron mass ratio and scaled value of β from the physical mass ratio corresponding to a two-species deuterium-electron plasma $\sqrt{m_e/m_D} = 0.00027$. The string `me1` indicates the physical value of mass and β, `me2` indicates that the mass m_e/m_i is reduced by a factor of 2, whilst β is reduced by a factor of $\sqrt{2}$, `me4` indicates that the mass m_e/m_i is reduced by a factor of 4, whilst β is reduced by a factor of 2, and so on.

For figures 13 and 14 a scan in the physical β at fixed mass and k_y is required. For these simulations we use the format

`rootname.ky.K.meN.beta.B.in`,

where `K` and `N` have the same meaning as above and `B` is the physical value of beta.

Using these input files one can create the required data to generate the figures presented in the manuscript. Included in this repository is a script

`../scripts/plot_lowbeta_figures.py`

that generates figures 2, 3, 8, 11, 12, 13, 14, once the appropriate `GS2` raw output data is provided. Note that the file

`../scripts/utils.py`

contains necessary utility functions. The remaining figures can be generated using the complex frequencies, fields and electron distribution function printed by `GS2` at the final timestep of a converged linear simulation, using the input files in this repository.