

Task Reconnection 1.

“Influence of guide field on magnetic reconnection”

Subtask 1. 1. MRX-MPS

Long term goal - Additional value of the interdisciplinary collaboration:

Magnetic reconnection can take place without or with a finite guide field which can vary from zero or comparable to reconnecting field component in magnetosphere to large or very large in tokomaks and solar flares. Since observations of the reconnection fields in solar flares are remote and indirect they are basically obtained by numerical simulations. The calibration of the resulting predictions on laboratory experiments is, therefore, very much desired. The long term goal is the investigation of the guide field dependence of 3-D collisionless magnetic reconnection and the comparison and verification of the results with MRX experiments, in attempts to compare to reconnection in fusion and in solar flares.

1.5 year plan

Goals:

Theory and simulation:

- Linear eigen value studies and nonlinear simulations of 3-D instabilities of the electron layer in the presence of guide field using EMHD model.
- Effect of the guide field on evolving turbulence generated by the instabilities, comparison with an independent set of EMHD simulations of homogeneous and non-homogeneous 3-D turbulence in the presence of external magnetic field.
- Tests of the 3-D PIC code by massively parallel runs for these problems
- 3-D PIC simulations of the instabilities of the electron layer with guide field and comparison with the EMHD simulations
- Comparison with the MRX results for finite guide field.
- Setting up and running EMHD and PIC simulations for the MRX experiment conditions, if results of the experiment are available.

Experiment:

- Study dependence guide field strength on fluctuations
- Measure ion heating and acceleration as a function of guide field

Interdisciplinary collaboration:

This work requires a close collaboration between basic laboratory experiments and solar simulation work.

Personnel:

Theory: Büchner, Jain (MPS): Running of 3D EMHD and later PIC code simulations

Experiment: Ji, Yamada, postdoc (PPPL): conducting MRX experiments

Possible Publications:

- Effect of guide field on the instabilities of the electron current layer in collisionless reconnection
- Guide field dependence of the generation of the electromagnetic turbulence due to the unstable electron current layer in collisionless magnetic reconnection.
- Effect on guide field on ion heating and acceleration during collisionless reconnection

Approximate 4 year plan

Goals:

Theory and simulation:

- PIC simulations of the guide field dependence of 3-D reconnection for the conditions of the MRX experiment
- 3D PIC code simulation of flux ropes and their interactions
- 3D PIC code simulation of reconnection through quasi-separatrix layers.
- Guide field dependence of spectral and transport properties of the turbulence generated in reconnection

- 3D PIC code simulation of forced reconnection (to mimic the external drive to the electron layer in reconnection) leading to the interplay of KH and tearing instabilities in the presence of guide field.
- 3D PIC code simulation to study coupling of ion and electron processes in 3-D reconnection.

Experiment:

- Study effects on boundary conditions and global effects on guide field dependence.
- Investigate reconnection in strong guide field limit from fusion and from solar