Plan Overview

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Title: Investigating Magnetospheric Plasma Dynamics with Large-scale Fully Kinetic Simulations

Creator: Silvia Ferro

Principal Investigator: Silvia Ferro

Data Manager: Silvia Ferro

Project Administrator: Silvia Ferro

Affiliation: KU Leuven (KUL)

Funder: Fonds voor Wetenschappelijk Onderzoek - Research Foundation Flanders (FWO)

Template: FWO DMP (Flemish Standard DMP)

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Project abstract:

This Ph.D. research proposal focuses on investigating the complex dynamics of plasma interactions in the Earth's magnetosphere driven by the Kelvin-Helmholtz instability (KHI) using fully kinetic simulations. The study aims to elucidate mechanisms governing energy transport, turbulent plasma dynamics, and plasma transport across the magnetosphere, with a particular emphasis on the role of electrons in small-scale processes. The investigation encompasses comprehensive analyses of electron energization, turbulent plasma dynamics, and plasma transport dynamics in the local and global evolution of the KHI. Each component of the study addresses specific aspects of plasma physics relevant to space weather prediction and understanding fundamental processes in magnetospheric environments. The proposal emphasizes the need for high-resolution kinetic simulations to capture small-scale physics accurately and underscores the importance of addressing this gap in current research to improve our ability to forecast space weather and understand the underlying physical processes driving plasma dynamics in space.

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Questionnaire

The questions in this section should only be answered if you are currently applying for FWO funding.
Are you preparing an application for funding?

- No

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DPIA

Have you performed a DPIA for the personal data processing activities for this project?

Question not answered.

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Investigating Magnetospheric Plasma Dynamics with Large-scale Fully Kinetic Simulations
GDPR

GDPR

Have you registered personal data processing activities for this project?

- Not applicable

Investigating Magnetospheric Plasma Dynamics with Large-scale Fully Kinetic Simulations
FWO DMP (Flemish Standard DMP)

1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

Dataset Name	Description	New or reused	Digital or Physical	Only for digital data — Digital Data Type	Only for digital data — Digital Data format	Only for digital data — Digital data volume (MB/GB/TB)	Only for physical data — Physical volume
		Please choose from the following options: • Generate new data • Reuse existing data	*Please choose from the following options:* • Digital • Physical	*Please choose from the following options:* • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA	*Please choose from the following options:* • .por, .xml, .tab, .csv,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
ECSim model	Code	Generate new data	Digital	Software	.c and .c++	<100 MB	N.A.
ECSim - Fields	Simulation data with the simulated fields	Generate new data	Digital	Simulation data	.h5	<1TB	N.A.
ECSim - Particles	Simulation data with the simulated particle quantities	Generate new data	Digital	Simulation data	.h5	<5TB	N.A.

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

N/A

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, …)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

The ECSim model will be accompanied by a comprehensive user guide that details the steps for compiling the code and running simulations. Additionally, to ensure the output data—formatted in .h5—remains understandable and usable, a Python script will be provided for post-processing. To further support accessibility and reproducibility, relevant documentation will be included, outlining key variables, data structures, and processing procedures.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- Yes

Yes, a metadata standard will be employed to facilitate finding and reusing of the data. Specifically, we will add the input file related to each run. In the input file, all the specific characteristics of the run are specified parameter-wise, along with a small description of the physics currently modeled.

3. Data storage & back-up during the research project

Where will the data be stored?

The storage solution to manage and preserve the data includes a shared disk space at VSC and a freely accessible data repository for publications. To ensure the reproducibility of our research, all data leading to publications will be stored for at least five years after the project's completion.

How will the data be backed up?

Regular backups will be performed by the IT staff.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.

- Yes

Before initiating each simulation, we perform both weak and strong scaling tests on the VSC cluster to evaluate the required computational resources. This process helps us estimate the necessary computational power and disk storage for archiving the database. By assessing disk space requirements in advance, we ensure efficient resource allocation and optimal performance.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

All data and model source codes will be managed in strict compliance with IT guidelines, including password protection for all computers and external drives. Our IT staff continuously implements security upgrades to ensure robust protection.
When sharing datasets, read-only permissions will be enforced to maintain data integrity and security.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

We do not anticipate incurring any supplementary expenses for data storage or backup, aside from the ongoing operational costs associated with the IT department, which KU Leuven covers.

4. Data preservation after the end of the research project

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

All data will be retained for a minimum of five years, with the possibility of longer retention periods.

Where will these data be archived (stored and curated for the long-term)?

Shared disk space at VSC, and a freely accessible data repository for publications.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

The storage solutions proposed are free of charge.

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in an Open Access repository
- Yes, in a restricted access repository (after approval, institutional access only, …)

The published results will be made available in an open access repository. However, the model source code will only be made available in a restricted access repository.

If access is restricted, please specify who will be able to access the data and under what conditions.

The code will be shared upon mutual agreement established, for example, through email correspondence.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- No

Where will the data be made available? If already known, please provide a repository per dataset or data type.

It is yet to be decided.

When will the data be made available?

Publication datasets will be made available upon manuscript acceptance. Access to the model source code will be restricted after the project concludes. Publication datasets will be made available upon manuscript acceptance. Access to the model source code will be restricted after the project concludes.

Which data usage licenses are you going to provide? If none, please explain why.

We do not intend to share our ECSim kinetic model as a community model. However, we will utilize this model with external collaborators under mutual agreement. As a result, we will not provide a license for its distribution.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- No

What are the expected costs for data sharing? How will these costs be covered?

There are no costs expected for data sharing.

6. Responsibilities

Who will manage data documentation and metadata during the research project?

Silvia Ferro

Who will manage data storage and backup during the research project?

Silvia Ferro

Who will manage data preservation and sharing?

Silvia Ferro

Who will update and implement this DMP?

Silvia Ferro

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