1 Report

by Gullik Vetvik Killie, Add yourself

Abstract

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1.1 Introduction

- State of the art
- Why are we doing this
- What is being done
- Aims of report/study (want to see if)

We are using something to prove something!!!

1.2 Theory

1.3 Numerical Methods

- Short PiC (EMSES) explanation
- Experimental set up
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1.3.1 Numerical methods

To solve the problem numerically we use the EMSES code. EMSES uses the standard PIC method for plasma simulations. In the code we are able to define a spacecraft body, and the code then calculates the potential on that body using the capacitance matrix method. Although EMSES has the capability to do a full electromagnetic calculation, we have opted to use the poisson's equation solver for electrostatic problems. In the EMSES system we can define sunlit surfaces based upon an angle, and a current desity. Sunlit surfaces will then emmit electrons based upon a energy distribution. For a complete description of EMSES' capabilities see (**nakashima˙ohhelp:˙2009**) Parameters are choosen to simulate the earth, but with an enhanced flux to emphasize the effect in question.

1.3.2 Test case setup

We wish to simulate the effects of Photon emmision in different test cases, and have thus set up the following 6 cases:

Case	Plasme flow	Photon emission
1:	41600 $\vec{e_x}$ m/s	0
2:	-41600 $\vec{e_z}$ m/s	0
3:	-41600 $\vec{e_y}$ m/s	0
4:	41600 $\vec{e_x}$ m/s	$-10^{-3}A/m^3$ $\vec{e_x}$
5:	-41600 $\vec{e_z}$ m/s	$-10^{-3}A/m^3$ $\vec{e_x}$
6:	-41600 $\vec{e_y}$ m/s	$-10^{-3}A/m^3$ $\vec{e_x}$

So test case 1-4, 2-5, and 3-6 are the "same" cases exept that we run the simulation with and without photon emission to compare the cases two and two.

1.4 Results

- Comparison of cases with P-E and without
- Acc of charges at probes + ϕ, diff flows and α
- ϕ num vs ana

1.4.1 Induced electric current

The plasma is flowing in in relation to the coordinate system in the simulations. Due to this an induced electrical field, ε, will appear. The induced electrical field will neutralize the Lorentz force. Combined with the electrostatic approximation we can obtain the ε

$$\vec{\varepsilon} = \vec{v_D} \times \vec{B} \tag{1.1}$$

$$\int E dx = -\phi \tag{1.2}$$

$$\phi = -\int \vec{v}_d \times \vec{B} \approx -\int (41600\text{m/s} \cdot 50E - 6\text{T})\, dx \tag{1.3}$$

$$\phi = -2.08\text{x} + C \tag{1.4}$$

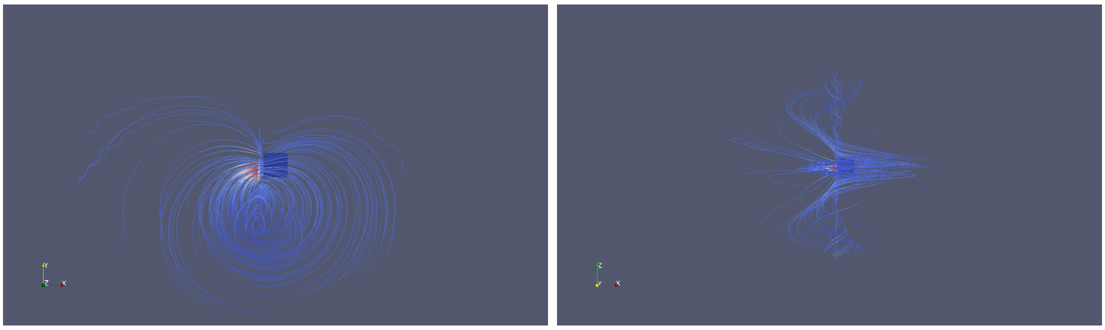

Figure 1.1: The trajectories of the electrons emmited by the photoelectric effect in simulation 6. It can be seen that some of the trajectories coincide with the volume occupied by the langmuir probes. The electrons are strongly affected by the magnetic field $\vec{B}$, and follows a gyrating path.

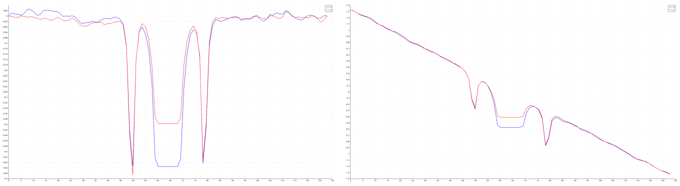

Figure 1.2: Potential of spacecraft and surroundings with P-E and without P-E. Figure on the left displays difference between case 1 and 4. Middle figure displays difference between case 2 and 5. Rightmost figure displays difference between case 3 and 6.

1.4.2 Photoemmision paths

1.4.3 Potential difference with P-E and no P-E

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Case 1 vs case 4

Need plot

Case 2 vs case 5

With the flow of emmited electrons in the negative x direction we would expect a rise in electron density around the left probe. This can be seen in the potential of this probe where there is a 5.4

Case 3 vs case 6

A rather large drop in potential of 12

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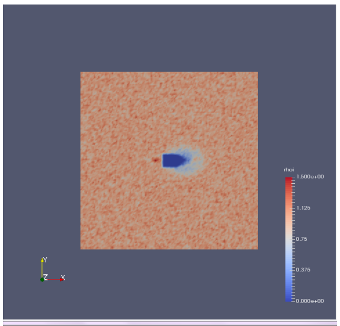
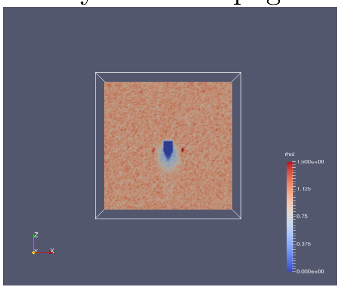
density case1.png



density x-z case2.png



density x-y case3.png

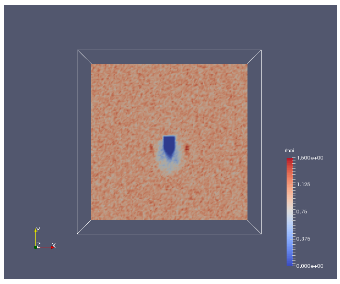


Figure 1.3: Ion density of spacecraft and surroundings without P-E. Figure on the left displays case 1. Middle figure displays case 2. Rightmost figure displays case 3.

1.4.4 Wake plots

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1.5 Discussion

1.6 Conclusions

- Proposal for further studies (Probably see if photoemmision is relevant in tenous plasma (MEO CASE, magnetospheric tail lobes))