1 Report

by Gullik Vetvik Killie, Steffen Brask 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
-

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

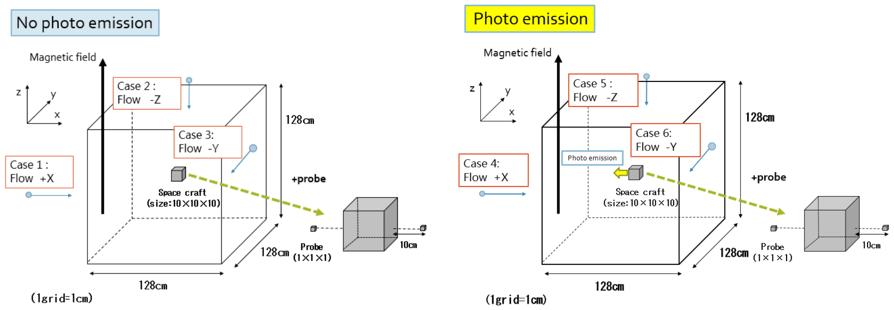

Figure 1.1: a description here

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 sun at the earth, but with an enhanced flux to emphasize the effect in question.

1.3.2 Theoretical calculations

$$I_i = \begin{cases} A|q|n_i\sqrt{\frac{8kT_i}{\pi m_i}} \\ \frac{1}{6}A|q|n_i V + \frac{5}{6}A|q|n_i\sqrt{\frac{8kT_i}{\pi M_i}} \end{cases}$$
$$I_e = -A|q|n_e\sqrt{\frac{8kT_e}{\pi m_e}}exp\left(\frac{|q|\Phi_d}{kT_e}\right) \tag{1.1}$$

1.3.3 Test case setup

We wish to simulate the effects of Photon emmited electrons 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

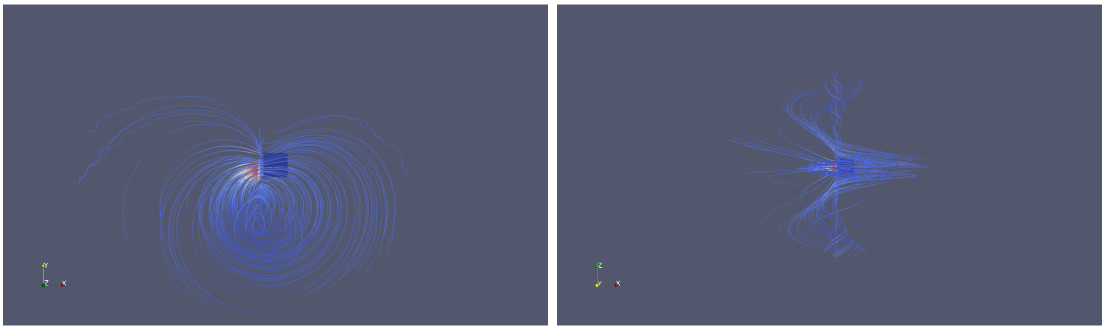

Figure 1.2: The trajectories of the electrons emmited by the photoelectric effect in simulation 6. It can be seen that some of the trajectories coincide with the volume occupied by the langmuir probes. The electrons are strongly affected by the magnetic field $\vec{B}$, and follows a gyrating path.

- 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

$$\vec{\varepsilon} = \vec{v_D} \times \vec{B} \tag{1.2}$$

$$\int E dx = -\phi \tag{1.3}$$

$$\phi = -\int \vec{v}_d \times \vec{B} \approx -\int (41600\text{m/s} \cdot 50E - 6\text{T})\, dx \tag{1.4}$$

$$\phi = -2.08\text{x} + C \tag{1.5}$$

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

Here we have the emitted electrons in the negative flow direction. As expected this leads to a drop in potential in the left probe which is facing the plasma flow. The potential drop over the probe is 3.8%. The right probe is now the wake where we have a drop in the ion density. This yields a large drop in potential compared to the left probe, but

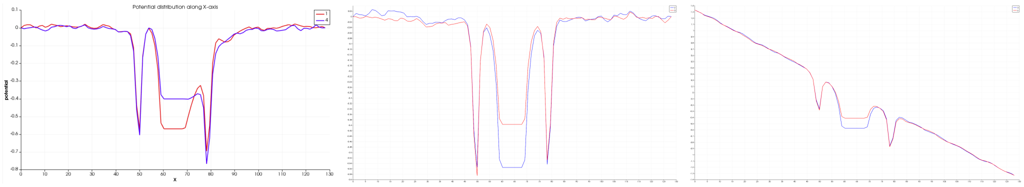

Figure 1.3: Potential of spacecraft and surroundings with P-E and without P-E. Figure on the left displays difference between case 1 and 4. Middle figure displays difference between case 2 and 5. Rightmost figure displays difference between case 3 and 6.

it also has a larger than the left probe when comparing case 1 and 4. This might be because the potential drop on the left side redirects more ions from the right side. The potential drop comparing the two cases is 10%. The potential rise over the satelite is 28%.

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% drop in the potential of this probe compared to no emitted electrons. On the right probe we have a small rise in potential of 3.3%. With no emitted electrons on this side of the satelite the rise in potential can be explained by looking at the increase in ion density as seen in figure (need ref). In the satelite we have a potential rise of 28%. So the change in potential in the probes are small compared to the change in the satelite.

Case 3 vs case 6

A rather large drop in potential of 12% on both probes. Potential rise of 26% over the satelite.

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Wake plots

1.5 Discussion

1.6 Conclusions

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

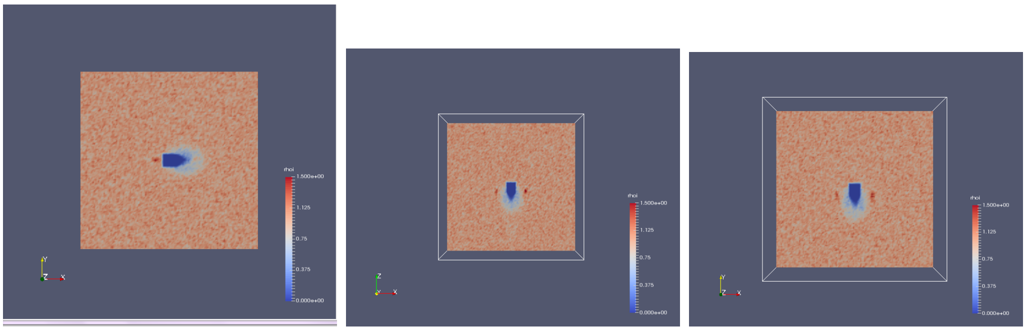

Figure 1.4: Ion density of spacecraft and surroundings without P-E Figure on the left displays case 1. Middle figure displays case 2. Rightmost figure displays case 3.