

Numerical Study on Ionization Structure and Shock Wave Propagation for Improving Flight Performance of Beaming Propulsion Vehicle

Report Number: R23EACA17

Subject Category: JSS Inter-University Research

URL: <https://www.jss.jaxa.jp/en/ar/e2023/23745/>

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● Abstract

In this study, our objective is elucidating the ionization-front propagation mechanism induced by high-power microwave in the microwave rocket.

● Reasons and benefits of using JAXA Supercomputer System

The use of JAXA supercomputer is required to conduct a three-dimensional multi-scale calculation which has a coupling module of the electromagnetic-wave propagation and the plasma-fluid model. This supercomputer use can contribute to investigation of the discharge phenomena induced by the high-power microwave.

● Achievements of the Year

We developed a three-dimensional computational code which has a coupling module of the millimeter-wave propagation and the plasma-fluid model. Generally, a part of the input millimeter wave is reflected in the ionization front because the number density of plasma exceeds the cut-off density of the millimeter wave. On these phenomena, our previous two-dimensional (2D) simulation has suggested that the reflected millimeter wave contains structural information on the ionization front and we can identify the ionization-front structure by capturing the electromagnetic wave reflected by the plasma. However, our proposal was verified only in the 2D simulation, and it is necessary to check the three-dimensional (3D) effects on the reflected wave and the discharge structure. Therefore, we conducted the 3D simulation for the microwave plasma, which revealed that the millimeter-waves were strongly reflected toward the elongation direction of the filaments in the fish-bone discharge structure. This strong reflection of the electromagnetic wave occurred in both E-k and H-k planes so that our proposal, which identifies the plasma structure by capturing the reflection wave, can be effective, regardless of the location of the antenna.

- **Publications**

N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	8 - 960
Elapsed Time per Case	24 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 0.09

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	36,754.43	0.00
TOKI-ST	707,457.87	0.76
TOKI-GP	0.00	0.00
TOKI-XM	3.13	0.00
TOKI-LM	13.05	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage* ² (%)
/home	510.00	0.42
/data and /data2	11,040.00	0.07
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage* ² (%)
J-SPACE	0.00	0.00

*¹: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*²: Fraction of Usage : Percentage of usage relative to each resource used in one year.

● ISV Software Licenses Used

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage* ² (%)
ISV Software Licenses (Total)	0.00	0.00

*²: Fraction of Usage : Percentage of usage relative to each resource used in one year.