Numerical Simulation on Ionization Structure and Shock Wave Propagation for Flight-performance Improvement of Beaming Propulsion Vehicle

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Abstract

To achieve a better design of beaming propulsion vehicle, we numerically reproduce propagation processes of beam-supported plasma and shock wave by simulation and evaluate beam-power dependence on discharge-structure and propagation speed.

Reasons and benefits of using JAXA Supercomputer System

A conputational cost becomes huge because temporal and spatial scales are different between discharge and shock wave propagation processes and a computational speed is limited by the discharge simulation. JAXA supercomputer, which has a huge calculation ability, is required to reproduce a propagation process of beam-supported plasma.

Achievements of the Year

An electromagnetic wave-plasma-shock wave-chemical reaction-radiation coupling simulation using fluid modeling indicated that a plasma propagation was sustained because radiation process induced a seed electron in front of the ionization front when a lower intensity beam was irradiated. When the beam intensity was decreased further, the propagation speed of the ionization front became slower because a thermal ionization process can be dominant on creation of the seed electron. The propagation speed obtained by the numerical simulattion had a good agreement with a tendency obtained by the experiment. We can determine the most suitable nozzle length of a beaming rocket based on the numerically estimated propagation speeds of the ionization front and shock wave.

Publications

N/A

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	1 - 256
Elapsed Time per Case	10 Hour(s)

Resources Used(JSS2)

Fraction of Usage in Total Resources[*1](%): 0.03

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	172,237.19	0.03
SORA-PP	0.00	0.00
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	476.84	0.44
/data	9,765.63	0.19
/ltmp	1,953.13	0.17

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.

- **Resources Used(JSS3)**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-RURI	0.00	0.00
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	476.84	0.33
/data	9,765.63	0.16
/ssd	95.37	0.05

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.