Numerical Plasma Simulation on Advanced Space Propulsion Systems

Report Number: R22EU0904
Subject Category: Space and Astronautical Science
URL: https://www.jss.jaxa.jp/en/ar/e2022/20892/

Responsible Representative
Ikkoh Funaki, Professor, ISAS

Contact Information
Ikkoh Funaki(funaki.ikkoh@jaxa.jp)

Members
Yuki Murayama, Ryoka Hayashi

Abstract

Due to the limitation of the existing spacecraft technology level, it is very difficult to enable solar system explorations in a quick and cost-effective mannger. Objective of this study is to obtain a breakthrough spacecraft propulsion technology that enables solar system exploration of the next generations.

Reasons and benefits of using JAXA Supercomputer System

Design optimization of spacecraft propulsion requires a huge computer resource, hence supercomputer usage is very important.

Achievements of the Year

Magsail is a space propulsion system using the interactions between the solar wind and the magnetic field generated by the onboard coils. Magnetoplasma sail is a propulsion system that increases thrust by expanding the magnetosphere through plasma injection from the spacecraft. There are two mechanisms on the magnetospheric inflation: method using frozen-in of magnetic field to carry magnetic field lines by high dynamic pressure plasma and method using the diamagnetic current by thermal plasma, which is called the ring current. We investigated the effect of the dynamic pressure and thermal pressure on the MPS thrust performance used electromagnetic hydrodynamic simulation. It was shown that the ring current is enhanced by adding dynamic pressure to the thermal plasma and increases thrust gain. The high thrust gain over 2.25 was obtained at beta_th=0.5 to 2 and beta_k=4 to 8. However, the thrust is reduced because the super magneto acoustic wave region is generated in the magnetosphere, which prevents the propagation of thrust in large beta conditions. The wide parameter survey reveals injection plasma parameter regions where thrust reduction is restrained and high thrust gain is obtained.

Publications

- Non peer-reviewed papers

Yuki MURAYAMA, Ryota HARA, Yoshiki YAMAGIWA, Yuya OSHIO, Hiroyuki NISHIDA and Ikkoh FUNAKI, Magnetohydrodynamic Analysis of Magnetoplasma Sail for Plasma Injection Angle considering Thermal Pressure and Dynamic Pressure, Journal of Evolving Space Activities, in press.

Usage of JSS

Computational Information

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

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 0.00

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	95,933.72	0.00
TOKI-ST	771.93	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	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	130.00	0.12
/data and /data2	800.00	0.01
/ssd	800.00	0.11

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.