Numerical Simulation of Advanced Spacecraft Propulsion

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Abstract

Numerical and physical modeling of　Magnetoplasmadynamic arcjet and other advanced spacecraft propulsion for future large space mission are conducted. Also, based on the modeling, performance prediction tool is organized.

Reasons for using of JSS2

Enough calculation resources (CPU and memory) are required to perform plasma simulation and to optimize spacecraft propulsion's performance.

Achievements of the Year

To clarify the plasma behavior on a self-field magnetoplasmadynamic thruster (SF-MPDT) at the critical current operation using hydrogen as a propellant, the flow-field was simulated numerically. In the simulation code, the ion-slip effect is incorporated as a numerical model. The numerical simulation was conducted for discharge current J = 5 kA, 10 kA (critical current) and mass flow rate of 0.4 g/s, in order to understand the plasma conditions at critical current level. At the critical current, the current path was extended to downstream of discharge chamber by increasing magnetic flux density and Hall effect, therefore the pressure raised at cathode tip and central axis. The blowing force was increasing at the critical current, because the current distribution at cathode tip was 5 times as large as the case of 5 kA and the self-induced magnetic field was equally increased. The ion-slip parameter was significantly occurred in large part of discharge chamber at the critical current (Sion greater than unity). The ion-slip heating was occurred at the supersonic region, and its caused to suppress the gas dynamic thrust.

Publications

- Presentations

1) Shin Tauchi, Akira Kawasaki, Masakatsu Nakane, Kenichi Kubota, Ikkoh Funaki, Numerical Analysis of the Effect of Cathode Configuration on Hydrogen MPD Thruster Performance, Asian Joint Conference on Propulsion and Power, AJCPP2018-027, March 2018, Xiamen.

Usage of JSS2

- Computational Information

Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelizatio
Number of Processes	32 - 512
Elapsed Time per Case	10.00 hours

- Resources Used

Fraction of Usage in Total Resources*1 (%): 0.04

Details

Computing Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	64,935.21	0.01
SORA-PP	36,403.88	0.46
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	047.68	0.03
/data	476.84	0.01
/ltmp	9,765.63	0.74

Archiver Resources		
Archiver System 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