Study on spacecraft dynamics

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● **Abstract**

Numerical analysis on the dynamics of various spacecraft are peformed. Specifically, we will (1) design of the flow path shape of the air intake of an air breathing engine used in a space transportation system, (2) evaluation of the interference between the thruster jet and the surface of a celestial body in a lander's landing, and (3) improvement of the motor gap flow characteristics of the canned motor pump for propellant supply system of a spacecraft.

● **Reasons and benefits of using JAXA Supercomputer System**

All themes are carried out in a complementary manner with experiments, and by using JSS3, analysis can be performed very quickly, making it possible to perform numerical analysis that is effective for setting experimental conditions and understanding experimental results.

● **Achievements of the Year**

(1) We designed the flow path shape of the air intake of an air breathing engine used in a space transport vehicle. Figure 1 shows the Mach number contour of the flow field. Figure 2 shows a comparison of the pressure distribution obtained from experiment and CFD.

(2) We evaluated the interference between the thruster jet and the surface of the celestial body when the lander lands on the celestial body. Figure 3 shows the analysis results (Mach number contour) of the thruster jet flow assuming the shape of the celestial body.

(3) We investigated the improvement of the motor gap flow characteristics of a canned motor pump for propellant supply to spacecraft. Figure 4 shows an example of gap flow analysis results (streamlines).
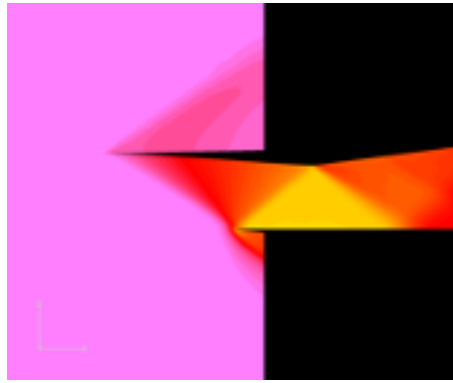
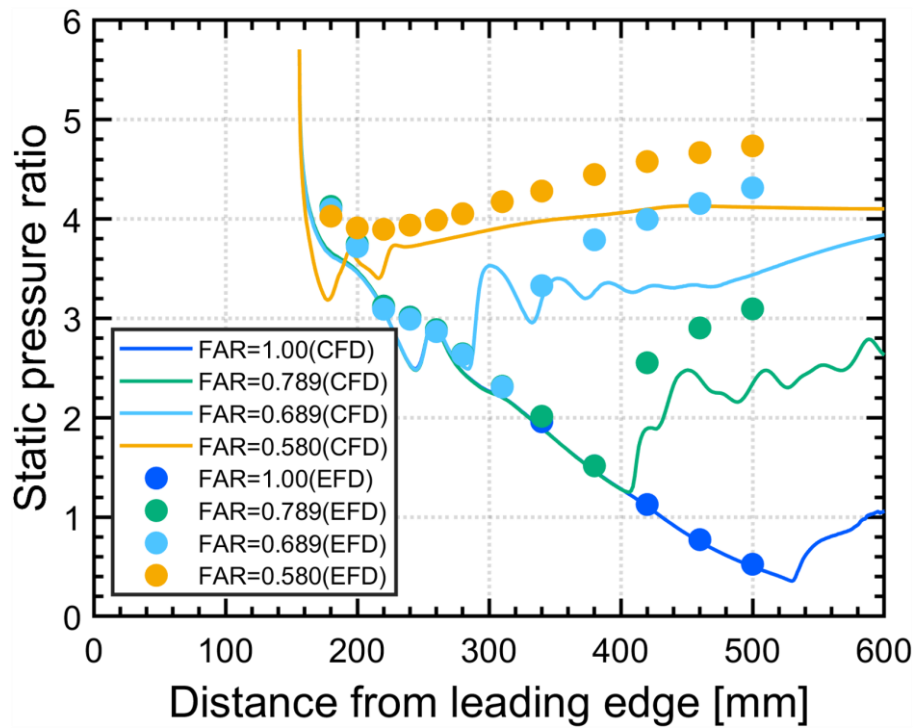Fig. 1: Mach number contour of intake flow field

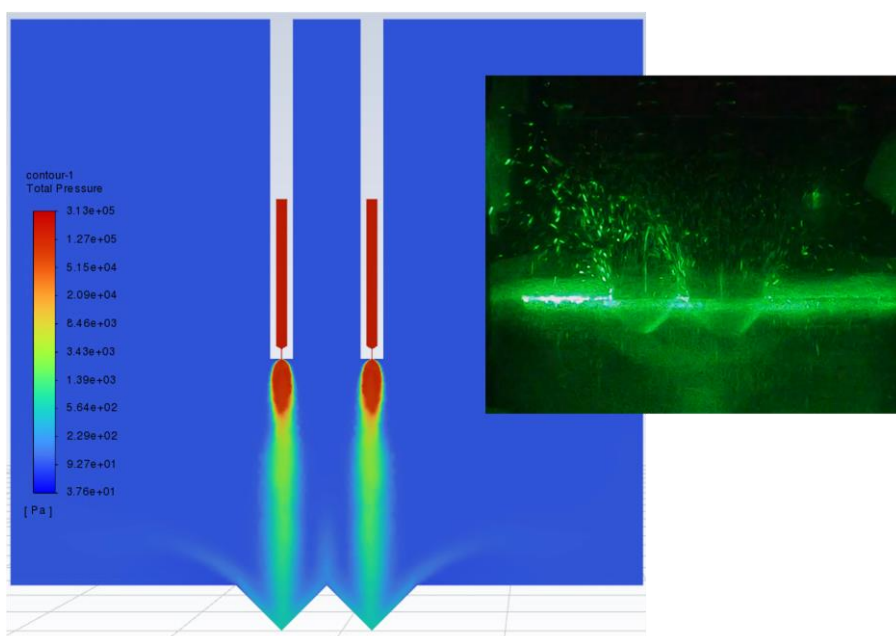Fig. 2: Comparison of pressure distribution obtained by experiment and CFD

Fig. 3: Analysis results of thruster jet flow (Mach number contour)
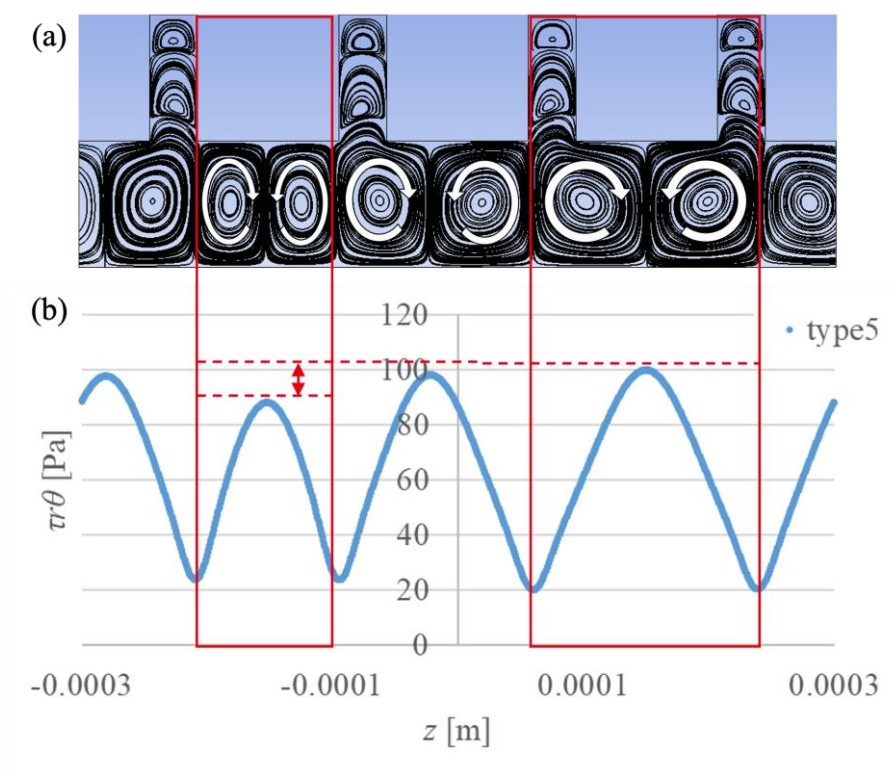

Fig. 4: Example of motor gap flow analysis results (streamline)

Publications

- Peer-reviewed papers

Maiko YAMAKAWA, Yusuke MARU, Mitsuhisa BABA, Yu DAIMON, Kazuhisa FUJITA, Shujiro SAWAI, Osamu MORI, Yuichi TSUDA: Scattering Tendency of Surface Objects during Thrusting in Vicinity of Celestial

Body, TRANSACTIONS OF THE JAPAN SOCIETY FOR AERONAUTICAL AND SPACE SCIENCES, AEROSPACE TECHNOLOGY JAPAN, vol.21,   pp. 29-35, 2023

- Oral Presentations

Kazuma Matsumoto, Haruaki Seta, Daiki Watanabe, Yusuke Maru, and Tetsuya Sato: Experimental and Numerical Investigation of a Three-Dimensional Supersonic Inlet for the Reusable Sounding Rocket with ATRIUM Engine, 34th International Symposium on Space Technology and Science (ISTS)

● **Usage of JSS**

●   **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	256
Elapsed Time per Case	8.3 Hour(s)

●   **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.26

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	2,865,244.85	0.13
TOKI-ST	411,751.75	0.44
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	20,099.06	1.53
TOKI-TST	38,373.43	0.63
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	1,070.00	0.89
/data and /data2	62,140.00	0.38
/ssd	400.00	0.04

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)	14,462.63	6.53

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