Paper ID: 70713
oral
student

IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Gravity and Fundamental Physics (1)

Author: Ms. Maiko Yamakawa
The Graduate Universty for Advanced Studies (SOKENDAI), Japan, yamakawa.maiko@ac.jaxa.jp

Mr. Taiga Tokuoka
Shizuoka University, Japan, tokuoka.taiga.18@shizuoka.ac.jp
Dr. Yusuke Maru
Japan Aerospace Exploration Agency (JAXA), ISAS, Japan, maru.yusuke@jaxa.jp
Dr. Yu Daimon
Japan Aerospace Exploration Agency (JAXA), Japan, daimon.yu@jaxa.jp
Prof. Shujiro Sawai
Japan Aerospace Exploration Agency (JAXA), Japan, sawai.shujiro@jaxa.jp
Prof. Kazuhisa FUJITA
Japan Aerospace Exploration Agency (JAXA), Japan, fujita.kazuhisa@jaxa.jp
Prof. Osamu Mori
The Institute of Space and Astronautical Science, Japan, mori.osamu@jaxa.jp
Dr. Makoto Yoshikawa
Japan Aerospace Exploration Agency (JAXA), Japan, yoshikawa.makoto@jaxa.jp
Dr. Yuichi Tsuda
Japan Aerospace Exploration Agency (JAXA), Japan, tsuda.yuichi@jaxa.jp

TENDENCY OF REGOLITH DISPERSAL BY FIRING MULTIPLE THRUSTERS OF SPACECRAFT ON CELESTIAL SURFACE

Abstract

When a spacecraft fires its thrusters at the surface of a celestial body, regolith on the surface of the celestial body is scattered vertically and adheres to the instruments onboard the spacecraft, such as cameras and ranging devices, degrading their performance. This problem was confirmed when the Japanese asteroid explorer Hayabusa2 touched down on the asteroid Ryugu. In the Hayabusa2 touchdown, a large amount of Ryugu regolith was scattered in the direction of the spacecraft. In Hayabusa2, the regolith adhered to the camera and ranging equipment during the touchdown, and the performance of the equipment was degraded. A large amount of regolith was also observed when NASA's OSIRIS-Rex touched down on the asteroid Bennu. Precise attitude control using the thrusters is essential for landing the spacecraft. Therefore, the scattering of regolith by thruster firing is a common problem for all spacecraft that land. The purpose of this study is to clarify that when plumes are injected from multiple thrusters, the plumes interfere with each other and the flow has a vertical component, which causes the regolith to scatter in the direction of the spacecraft under the influence of the flow. The authors have discussed the simplest mechanism of regolith dispersal by thruster injection, i.e., regolith dispersing along the wall of a crater formed by a single thruster injection. However, when considering the scattering of regolith in an actual spacecraft, it is necessary to consider the effect of multiple thrusters installed in the spacecraft. In other words, the plumes injected from multiple thrusters collide and interfere with each other to generate a plume flow in the direction of the spacecraft, and the regolith scatters along the flow. In order to investigate the effect of interference between plumes injected by multiple thrusters on the scattering of regolith, we conducted an experiment in which multiple thrusters were injected into

a sandbox under vacuum conditions, and obtained the trajectories by image analysis. The obtained trajectories were compared with the trajectories of the regolith dispersed by a single thruster injection, and it was confirmed that the interference of multiple plumes affected the dispersal of the regolith. The effect of plume flow on regolith dispersal was also evaluated by comparing the regolith trajectory obtained by image analysis with the density and velocity distributions of the plume obtained by CFD. In addition, we studied the layout of the spacecraft's instruments to prevent contamination by regolith during landing.