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Colloidal Clusters 宇宙実験実施の概要

Overviews of Colloidal Clusters Experiment in Space

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1. Introduction

A colloidal clusters experiment was carried out near the end of July 2020. Since development of experimental equipment was reported in the previous conference, JASMAC-32, other results related to an on-orbit experiment are reported in this JASMAC-33.

2. Time Series

An equipment for a colloidal clusters experiment (OpNom: Colloidal Clusters) was handed over in the middle of September 2019. An external view of equipment is shown in **Fig. 1**. The equipment is robust and simple to avoid any trouble. The equipment was transported to the Cargo Mission Contract (CMC) at the Johnson Space Center. Since samples have limited lifetime, samples were delivered in early December 2019 due to late access.

The equipment and samples were launched by SpX-19. After SpX-19 was docked with the International Space Station, the equipment was stored in pressurized stowage at cabin air temperature of about 22 degrees centigrade. Sample containers were stored in FROST (refrigerator) at 4 degrees centigrade to extend sample lifetime, though the containers were placed at the cabin air temperature for the first month because FROST was in use. After SpX-19 was unberthed, the containers were stored in FROST. At that time, the experiment was not scheduled. We had to wait for a chance of experiment. After about eight months were passed, the chance had come.

The colloidal clusters experiment was carried out from 27 July 2020 to 30 July 2020. The samples were mixed well by breaking a separator by a crew. Then the sample bags were set inside the equipment. After that, the equipment was quietly placed at the pressurized stowage for two days to form colloidal clusters. The equipment was picked up from the stowage and was set on the door of work volume of MSPR (Multi-purpose Small Payload Rack). The electric power was supplied for two hours from the work bench (WB) power supply to turn on a UV LED unit inside the equipment. The UV LED unit was used to gelate the samples. The current and voltage of the WB power supply are shown in **Fig. 2**. It is confirmed that the power was supplied as planned.

After the UV LED unit was turned off, the samples bags were taken from the equipment and were stored in the sample containers at the cabin air temperature until the samples were recovered. The samples were recovered by SpX-21, which was splashed down in January 2021. The samples were transported by an ordinal method and arrived in March 2021 at the Tsukuba Space Center. It was quickly confirmed that sample conditions were good. The samples were sent to the investigators as soon as possible. Now the samples are under evaluation.

Fig. 1 External view of equipment

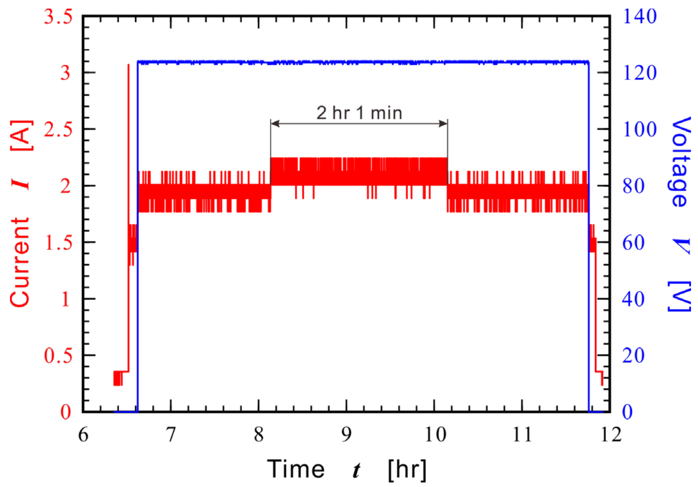

Fig. 2 Monitor results of WB power supply

2. Microgravity Environment

The microgravity is essential in this experiment since the colloidal particles made of titania are settled down in a very short time. Unfortunately, a reboost was scheduled during the experiment. Therefore, we obtained the SAMS-II (Space Acceleration Measurements System II) data from the NASA web site to know reboost influence on particle sedimentation. Effective G is calculated from the data by calculating a FFT spectrum. The result is shown in **Fig. 3**. The maximum effective gravity is about 1.7×10^{-4} G for the reboost period, while the ordinal effective gravity is about 3×10^{-5} G. In the gravity of 1.7×10^{4} G, that is, 1.7×10^{-3} m/s^2, the sedimentation rate is calculated to be 3.1×10^{-10} m/s from the Stokes' law. If the effective G of 1.7×10^{-4} G is maintained for three hours, the sedimentation distance is 3.3×10^{-6} m. Although this is an overestimated value, the sedimentation distance is negligibly small as compared with the bag thickness of a few millimeters.

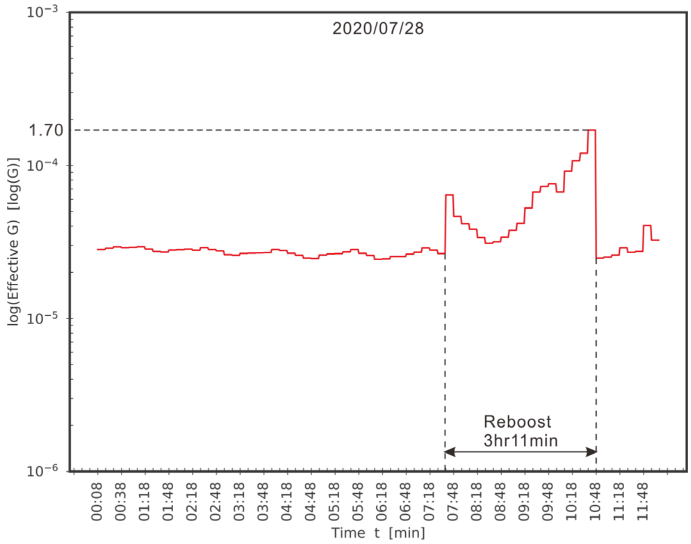

Fig. 3 Gravity change during reboost

3. Conclusions

The colloidal clusters experiment was carried out in the end of July 2020. Unfortunately, the investigators could not join in the user operation room due to the coronavirus crisis. Therefore, we used live streaming video so that the investigators could know the experiment operations in real time. The experiment operations were fully successful as planned without any major trouble. We think successful operations are brought by a robust and simple equipment.

Acknowledgment

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