NanoRocks2

Lisa M. Gaglio, Michael F. Patney, Cameron, R. Scott, Joshua E. Colwell
Department of Physics, College of Sciences

The Center for Initiatives in STEM

Introduction

NanoRocks, an International Space Station experiment, studied the bouncing-to-sticking transition in collisions of particles with decreasing velocity, recording multiple particle collisions in a 1.5 U long-duration, microgravity setting.

- NanoRocks2 continues this exploration, examining how mm and cm-sized particles with diverse materials and shapes behave during low-energy collisions in microgravity.
- This version of the experiment is testing this topic in 1D motion.
- The experiment aims to understand the underlying mechanisms influencing particle interactions, velocities, and the factors determining whether particles bounce apart or stick together.

Background

- Planet formation initiates with small dust particles gathering around newly formed stars in protoplanetary disks.
- Through particle motion and collision, these particles stick together and grow.
- However, the challenge arises when considering the limitations of this sticking process in the later stages of planetary development, posing questions about the formation of larger celestial bodies.

Figure 1. Image of Planet Mercury

Methods/Materials

- NanoRocks2's particle chamber has four different trays with varying numbers of chambers, this allows for tray interchangeability.
- The oval-shaped table on which the trays rest limits motion to the oval's direction when shaken.
- To achieve this, a single solenoid and two compression springs are employed.
- The solenoid taps the tray, inducing one-directional particle motion, and the springs restore the tray to its original position on the opposite side.

Table 1. Different types of particle materials in each of the four Test Trays by chambers

Particle Tray Number	Particle Type					
1	Chamber 1: Copper Shot (0.8-2mm)	Chamber 2: Acrylic Goldplate Spheres (2mm)	Chamber 3: Pebbles	Chamber 4: JSC-Mars-GT500 (Micron)	Chamber 5: UCF Baseball Dirt	Chamber 6: Purple Rocks (>500 Microns)
2	Chamber 1: Steel Beads	Chamber 2: Steel Rods	Chamber 3: Aluminum Rods		Chamber 4: Simulated CI Orgueil (Meteorite)	Chamber 5: Silica Beads 0.87-1.18 mm
3	Chamber 1: Bronze Marbles			Chamber 2: Aluminum Marbles		
4	Chamber 1: Marbles: Blue (10.15mm) White(10.15mm)					

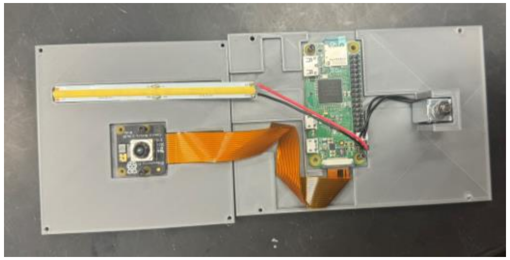


Figure 2. Electrical testing setup

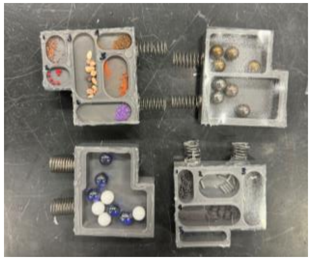


Figure 3. Different Particle Trays with designated materials

Discussion/Conclusion

- Preliminary simulations offer initial insights into particle velocities from trays three and four.
- This project is still in the experimental testing phases therefore data has not been obtained.
- The current focus is on completing the operational payload container, integrating key electronic components (Pi camera, Pi-Zero 2, 5V solenoid, and 5V LED lights) for easier tapping and recording during parabolic flights simulating outer space conditions.
- These flights are crucial for collecting data, and a comprehensive analysis will follow to understand particle interactions, velocities, and the factors influencing their bouncing apart or sticking together.
- However, as of now there is not a scheduled flight to test this experiment.

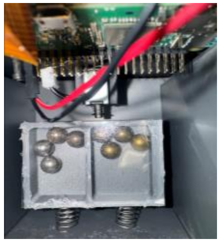
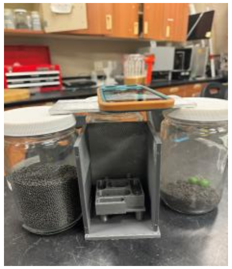


Figure 4. Mini-payload box set up, with all components

Figure 5. Preliminary experimental setup with the payload testing chamber along with a device to capture the video recording



Acknowledgments

I would like to thank Sarah Evans and UCF EXCEL for their amazing undergraduate research program. I would also like to thank Joshua Colwell, the staff and, the research students of the Stephen W. Hawking Center for Microgravity and Education.

References

1. Brisset J, Colwell J, Dove A, Maukonen D. NanoRocks: Design and performance of an experiment studying planet formation on the International Space Station. Rev Sci Instrum. 2017 Jul;88(7):074502. doi: 10.1063/1.4991857. PMID: 28764536.
2. Stephanie Jarmak, Julie Brisset, Joshua Colwell, Adrienne Dove, Douglas Maukonen, Samir A. Rawashdeh, Jürgen Blum, Larry Roe,
3. CubeSat Particle Aggregation Collision Experiment (Q-PACE): Design of a 3U CubeSat mission to investigate planetesimal formation, Acta Astronautica, Volume 155, 2019