Lunar Regolith Simulant Behavior in Microgravity Environments: A NASA TechRise Proposal

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Astral Orbit

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1 Proposal Budget

Our project's proposed budget is **under** the required amount of $1,500. This includes the following **materials**:

Material Name	Purpose
Lunar regolith simulant	For observation
Custom-designed PCB	To trigger cameras and record sensor data
Cameras	For qualitative analysis of regolith behavior

Table 1: Necessary Materials and Their Purposes

2 Vehicle Selection

Our team has selected to launch our experiment onboard the **sounding rocket**.

3 Proposal Narrative

3.1 What is your team's experiment idea?

The purpose of this experiment is to simulate and observe the behavior and properties of lunar regolith in microgravity and vacuum. These observations include the assessment of how the regolith interacts with other regolith particles and aggregates as well as how it interacts with other commonly used spaceflight materials.

Due to the infeasibility of acquiring actual lunar regolith directly from the surface of the moon, a simulant of the regolith must be used. As a result, this project will also require the procurement or production of a lunar regolith simulant. NASA has set forth a series of guidelines when preparing lunar regolith simulant [1]. Another major portion of this project is determining which regolith simulants work best for certain applications in microgravity, alongside the main objective of examining the regolith's properties in space.

3.2 Why do you want to propose this experiment idea?

Lunar regolith presents many challenges to lunar missions, including landing visibility, adhesion to space suits, pollution of habitats, and destruction of joints in moving parts [2]. These issues are especially relevant at the moment since NASA is currently planning the Artemis missions to go back to the moon. These missions would greatly benefit from an enhanced knowledge of the behavior of the regolith dust and its properties in microgravity conditions: by learning more about how lunar regolith behaves, engineers will be better prepared to design missions to be protected from its negative effects.

3.3 How will you build your experiment?

The lunar regolith will be placed in a sealed container that has transparent ports to allow for camera visibility. These cameras will observe and record how the regolith floats in the space environment and if it undergoes any aggregation. A custom PCB flight computer will be used to trigger the cameras and record the data.

The regolith will be triggered to float by a combination of accelerations acting on the vehicle and the payload. While the vehicle is in powered flight, the upward acceleration of the vehicle will keep the regolith at the bottom of the container due to the effect of apparent weight. However, when the motor burns out and drag takes over, the gradual deceleration of the vehicle will begin sending the regolith upwards relative to the container. After drag becomes negligible and microgravity is attained, the regolith particles will be left in a floating state, ready to be studied. At this point, the cameras will engage and the active experiment will begin.

3.4 When will you complete the different phases of your experiment build?

Table 2 lists the key dates, milestones, and criteria for this project.

Milestones	Date Completed	Milestone Criteria
Selected as Winner	January 21, 2022	Proposal submitted that details our team's winning design
Review of Proposed Design	February 14, 2022	Design review finished and preliminary changes to proposed experiment
Components Ordered	February 21, 2022	All required materials (Section 1 - Proposal Budget) ordered
Build Begins	March 7, 2022	Planning phase completed, construction and prototyping phase of experiment begins
Prototype Review	April 7, 2022	Functional prototype constructed, any necessary changes are identified
Final Design Review	May 21, 2022	A nearly finished product completed, held for review for final design changes
Experiment Mailed to Future Engineers	June 14, 2022	Experiment fully tested and shipped to Future Engineers

Table 2: Key Timeline Dates and Criteria

4 Team Information

Our school is **Title 1 eligible**. Table 3 lists the grade distribution of our team.

Grade	# of Students
6th Grade	0
7th Grade	0
8th Grade	0
9th Grade	6
10th Grade	3
11th Grade	3
12th Grade	3
Total Students: 15	

Table 3: Team Grade Breakdown

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References

[1] L. Sibille et al. *Lunar Regolith Simulant Materials: Recommendations for Standardization, Production, and Usage*. NASA, 2006. URL: https://ntrs.nasa.gov/api/citations/20060051776/downloads/20060051776.pdf.

[2] Matt Williams. *Lunar Dust is Still One of The Biggest Challenges Facing Moon Exploration*. 2020. URL: https://www.universetoday.com/148729/lunar-dust-is-still-one-of-the-biggest-challenges-facing-moon-exploration/.