

Fiscal Year:	FY 2023	**Task Last Updated:**	FY 01/11/2024
PI Name:	Liao, Ya-Ting Ph.D.		
Project Title:	Predicting Material Flammability in Partial Gravity Using Microgravity and Ground Data		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	44106-1712	**Congressional District:**	11
Comments:			
Project Type:	GROUND,Physical Sciences Informatics (PSI)	**Solicitation / Funding Source:**	2022 Physical Sciences NNH22ZDA001N-PSI E.8 Physical Sciences Informatics
Start Date:	08/01/2023	**End Date:**	07/31/2025
No. of Post Docs:	1	**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NASA GRC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):			
Grant/Contract No.:	80NSSC24K0310		
Performance Goal No.:			
Performance Goal Text:			
	As NASA and commercial space companies expand their exploration into deeper space, spacecraft fire safety has become more important than ever. While knowledge of fire dynamics in microgravity has accumulated over the past few decades, there is a knowledge gap about how fires behave and how materials burn in partial gravity environments (e.g., on the Moon or Mars surfaces). Previous research has shown that material flammability and fire risk can be greater in partial gravity than both normal and microgravity. To ensure safety and success of future space missions, there is an urgent need to advance the understanding of fire dynamics in partial gravity. In this proposal, it is hypothesized that burning behaviors and flammability boundaries of solid materials in partial gravity can be predicted using data collected in normal and microgravity. The overall goal of this project is to leverage the rich dataset collected in previous microgravity experiments to advance understanding of fire behaviors in partial		

Task Description:	gravity. The microgravity data will be complemented by existing and new ground data to lead to new science. Ultimately, we want to answer the following questions. "What can we learn from the microgravity data obtained in different experiments and different ambient conditions regarding material flammability in partial gravities?" "How do we predict burning behaviors in partial gravity using data collected in normal and microgravity?" The project consists of three major components. The first component is analysis of previous microgravity data. Tools will be developed to analyze data available on the NASA's Physical Sciences Informatics (PSI) system for microgravity combustion experiments (Burning and Suppression of Solids/BASS, BASS-II; Spacecraft Fire Safety Spacecraft Fire Safety Experiments: SAFFIRE-I, SAFFIRE-II, and SAFFIRE-III). Flame characteristics including spread rate, length, appearance, color, and flammability boundaries will be extracted, documented, and compared. Other microgravity datasets (e.g., International Space Station/ISS Confined Combustion project) will also be considered. This will result in a comprehensive inter-project meta-analysis of the current knowledge on microgravity combustion. The second component of the project is ground experiments. Burning experiments will be performed in a combustion chamber in the Principal Investigator (PI) lab with different environmental conditions. The experimental setup and sample selections will resemble the PSI microgravity experiments, enabling direct comparisons of ground and space data. This will allow us to correlate the gravity-induced buoyancy flows (in normal gravity) to the imposed flows in microgravity, in terms of their effects on the burning process. The third component will be numerical simulations. Both microgravity and ground experiments will be simulated. After the model is validated against the experimental data, the detailed profiles obtained in the numerical simulations will be used to understand underlying physics of the experimental observations. The model will then be able to simulate solid burning in different partial gravities, leading to a more complete understanding of the role of buoyancy flow on fire behavior. Through these efforts, we will identify invariant dimensionless parameters for flame spread and develop correlations between burning characteristics and the identified dimensionless parameters. These dimensionless parameters will incorporate various variables, including sample dimensions (e.g., width, thickness); gravity; and ambient conditions (pressure, flow speed, oxygen percentage). All generated outcomes will be made available for future investigators to test theories or train models.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This directly contributes to the advancement of fire science. The developed understanding of burning behaviors in partial gravity will help improve testing and design of future space vehicles. The ultimate goal of this project is to reduce tragic loss of life and property both on Earth and in space.
Task Progress:	New Project for FY2023
Bibliography Type:	Description: (Last Updated:)