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Fiscal Year:	FY 2024	Task Last Updated:	FY 10/02/2023
PI Name:	Weeks, Eric R Ph.D.		
Project Title:	Thermal Fluctuations of Colloidal Gels		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline Element/Subdiscipline:	COMPLEX FLUIDS/SOFT MATTERC	omplex Fluids	
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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Comments:			
Project Type:	Physical Sciences Informatics (PSI)	Solicitation / Funding Source:	2020 Physical Sciences NNH20ZDA014N: Use of the NASA Physical Sciences Informatics System – Appendix G
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No. of PhD Candidates:	1	No. of Master' Degrees:	0
No. of Master's Candidates:	0	No. of Bachelor's Degrees:	0
No. of Bachelor's Candidates:	1	Monitoring Center:	NASA GRC
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Flight Program:			
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COI Name (Institution):			
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Task Description:	We propose to study colloidal gels using the data from the Advanced Colloids Experiment-Microscopy-1 (ACE-M-1) experiments. Colloidal gels are formed from sticky micron-sized solid particles in a liquid, where over time the particles stick together and form random clumps that eventually bridge across the entire sample chamber in tangled networks. The ACE-M-1 data set consists of a large number of optical microscopy movies of colloidal gels. In microgravity, these gels are long-lived, rather than collapsing under their own weight as happens in ground-based experiments. Our group has expertise in analyzing microscope images, using particle tracking, particle image velocimetry, and differential dynamic microscopy. The movies reveal the gels have visible thermal fluctuations that likely reveal information about their rheological properties, local elasticity, etc. There is also some clear sense of length scales: some gels have thick aggregated regions, while others have more tenuous gel strands and free particles. We can connect structure and dynamics. We propose to analyze these movies to pull out this information, and to perform complementary ground-based experiments to validate the observations. For example, the Physical Sciences Informatics (PSI) movies are all 2D cuts through 3D samples, and we will use ground-based confocal microscopy to cross-check the samples with some 3D data sets; to confirm inferences about 3D structure from the 2D images. A particular appealing feature of the ACE-M-1 experiments is that they studied polydispersity (gels made of mixtures of two distinct particle types) and polydisperse systems are a long-time interest of the Principal Investigator (PI). We will use our ground-based experiments to study gels with higher polydispersity, which should in turn suggest new microgravity investigations in the future. This PSI investigation will be done by the Weeks lab at Emory University; there will not be any other collaborators.			
Rationale for HRP Directed Research:				
Research Impact/Earth Benefits:	Colloids are suspensions of small solid particles suspended in a liquid. Examples include paint, ink, pastes, and blood. "Small" means the particle diameters range from ~10 nm to ~10 microns. Thermal motion is relevant: Brownian motion allows particles to diffuse. Often precautions are taken to prevent the solid particles from sticking together. If particles have attractive interactions, they can stick together in free-floating aggregates, or large tendrils that can span across the system. The latter is a colloidal gel. Colloidal gels are used in applications such as water purification, skin creams, and also show up in some food products such as jellies and jams. In food, colloidal gels modify the texture and shelf-life stability of the food. Our NASA-funded study of colloidal gels should improve our understanding of long-term stability of colloidal gels, as well as how they initially form.			
Task Progress:	RESULTS FOR MICROGRAVITY DATA: The Advanced Colloids Experiment-Microscopy-1 (ACE-M-1) data set has 9 distinct experiments on 8 different samples, where the different samples are made with different levels of attractive interaction – that is, different levels of particle stickiness. Undergraduate student Swagata Data studied the ACE-M-1 data in 2022 working with the Principal Investigator (PI) Eric Wecks. We have determined that of the 9 experiments, 4 are suitable quality to be fully analyzed. These experiments have 50-60 hours of data each. Fortunately, these four experiments include the one with the highest attractive interaction, and also the one with the lowest attractive interaction, thus spanning the entire range. The samples are composed of equal amounts of small (1.8 micron diameter) and large (2.2 micron diameter) particles. In general, these two particles species behave similarly, although results below will show behaviors of both to highlight any differences. We have learned several interesting facts about the data. First, the colloidal gel samples show aging: the dynamics slow down as a function of time. Mean square displacement curves taken from different time points in the sample show that particles diffuse slower than normal diffusion: the curves rise with lag time dt showing that particles diffuse slowed the (1.0). The dynamics are noticeably slower as the sample ages from 2 hours to 56 hours since preparation. For the non-gel sample, the mean square displacement curves taken at different time points are essentially the same, and the curves rise as dr(1.0), indicating the particles diffuse normally rather than theight stronger attractions have higher peaks. Moreover, the peak height of malong particles a certain distance from each other. Samples with stronger attractices have higher peaks. Moreover, the peak height of storger attractive is storger peak height) that an every store as the sample ages from 2 hours to both. NEW GROUND-BASED EXPERIMENTS: This past year we have additionally done grou			

neighboring particles that stick to them. We will determine how the number of attached neighbors scales with the particle size.

Bibliography Type:

Description: (Last Updated: 06/24/2025)