Fiscal Year:	FY 2020	**Task Last Updated:**	FY 02/11/2022
PI Name:	Marr, David W.M. Ph.D.		
Project Title:	Dynamics of Complex Colloidal Molecules		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	COMPLEX FLUIDS/SOFT MATTER--Complex 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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Zip Code:	80401-1887	**Congressional District:**	7
Comments:	https://		
Project Type:	Ground	**Solicitation / Funding Source:**	2013 Complex Fluids & Macromolecular Biophysics NNH13ZTT001N
Start Date:	10/01/2019	**End Date:**	03/31/2023
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
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No. of Bachelor's Candidates:		**Monitoring Center:**	NASA GRC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Wu, Ning Ph.D. (Colorado School of Mines)		
Grant/Contract No.:	80NSSC19K1725		
Performance Goal No.:			
Performance Goal Text:			
Task Description:	This is a continuation proposal (previous grant "Fabrication, Crystallization, and Folding of Complex Colloidal Molecules under the Influence of Applied External Fields" NNX13AQ54G) for studies developing fluorescent labelling techniques for fabricating colloidal chains with improved imaging on the International Space Station (ISS). In general, this work is based on the use of colloidal particles as molecular analogues for self- and directed assembly investigations with goals toward understanding fundamental questions in material science including both equilibrium phase behavior and kinetic processes. Building on studies by researchers over recent decades, we move here beyond relatively small sizes, simple symmetries, and rigid structures which have prevented accessing the full diversity of fundamentally and technologically relevant structures. Specifically, we will investigate the behavior of colloidal chains that closely resemble natural and synthetic macromolecules with tunable chain length, flexibility, composition, and architecture. First, we will study the folding dynamics of colloidal chains in three dimensions and under microgravity. The		

	experimental measurements will be compared with theories for polymeric molecules and numerical simulations based on fluctuating hydrodynamics. Second, we will perform experiments on the 3D assembly of two-dimensional microwheel-like colloidal clusters induced by depletion interactions.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	In-situ manipulation of anisotropic interactions and dynamic pathways, based on rational colloidal particle design and proper use of external fields, could lead to crystalline and aperiodic structures beyond those seen in nature. The development of new colloidal molecules and their associated assembled structures may have considerable technological impact. Anisotropic interactions developed in this proposal, both at the particle level and via applied fields, have been shown generally to lead to arrays with reduced symmetry and enhanced directionality. Such structures interact with a broad range of electromagnetic radiation in unique ways and can exhibit collective photonic, plasmonic, mechanical, electronic, or magnetic properties that are not manifested at the level of single particles. As a result, they have significant potential as next-generation functional materials. For example, dielectric arrays with diamond-like or quasicrystalline lattices have been proposed as ideal photonic crystals that can manipulate light propagation in three dimensions, forming the basis for next-generation all-optical communication technologies. Chiral tetramers studied here could exhibit distinct plasmonic properties resulting from the collective coupling between particles in the pyramid, as confirmed in numerical modeling, which have great potential for electromagnetic metamaterials and high-resolution sensors. The understanding of mirror-symmetry breaking in racemates is also important for developing improved strategies for separation of pharmaceutical molecules. In addition, anisotropic particles can be used to generate new kinds of colloidal networks with well-defined coordination and connectivity. By combining families of tetramers and chains, double networks – two distinct, but interpenetrating, networks of nodes and linkers – could be formed with combined high mechanical stiffness and high toughness. Colloidal networks are very common in a range of pharmaceutical and consumer production applications because of their ability to impart a yield stress that can stabilize active components uniformly throughout the formulation. Developing methods to produce colloidal networks with defined coordination, connectivity, and topology would expand the use and performance of colloidal stabilizing networks in these materials. Ultimately, successful implementation of our proposed research will provide the fundamental knowledge necessary for the development of technologies to design and control matter with tailored structures and properties.
Task Progress:	New project for FY2020. [Note added to Task Book in February 2022 when received information.]
Bibliography Type:	Description: (Last Updated: 06/13/2025)