Task Book Report Generated on: 04/25/2024

P. Name:   Clark, Nocl A. Ph.D.	Fiscal Year:	FY 2017	Task Last Updated:	FY 03/27/2017
Physical Sciences	PI Name:	Clark, Noel A. Ph.D.		
Program/Discipline:   Program/Discipline-  Element/Subdiscipline:   Joint Agency Name:	Project Title:	Ferromagnetic Liquid Crystal Colloids in Microgravity		
Program/Discipline-  Element/Subdiscipline-  Subdiscipline-  No	Division Name:	Physical Sciences		
Element/Subdiscipline:  Joint Agency Name:  Joint Agency Name:  Human Research Program Elements:  None  Human Research Program Risks:  None  Space Biology Cross-Element  Space Biology Cross-Element  Space Biology Special Category:  None  PI Email:  PI Organization Type:  UNIVERSITY  Organization Name:  UNIVERSITY  Or	Program/Discipline:			
Human Research Program Elements: None Human Research Program Risks: None Space Biology Element: None Space Biology Cross-Element Disciplinar: None Space Biology Special Category: None PI Email: none-clark/Geolorado-de/u Fax: FY 10 Gragnization Type: UNIVERSITY Phone: 303-941-1008 Organization Type: UNIVERSITY Phone: 303-941-1008 Organization Name: University of Colorado PI Address 1: Physics Department, CR390 PI Address 2: 2000 Colorado Ave PI Web Page: City: Boulder State: CO Zip Code: So399-0001 Congressional bistrict: 2 Comments: Project Type: FLIGHT Solicitation / Funding Materiald alo Open Science Source Computer Computer Source Computer Comp		COMPLEX FLUIDS/SOFT MATTERComplex Fluids		
Human Research Program Risks:   None	Joint Agency Name:		TechPort:	No
Space Biology Element:         None           Space Biology Cross-Element Discipline:         None           Space Biology Special Category:         None           PI Email:         moel.clark@colorado.edu         Fax:         FY           PI Organization Type:         UNIVERSITY         Phone:         303-941-1008           Organization Name:         University of Colorado         Phone:         303-941-1008           PI Address 1:         Physics Department, CB390         PI - Colorado         PI - Colorado         PI - Colorado           PI Web Page:         Cliy:         Boulder         State:         CO           Jip Code:         80309-0001         Congressional District:         2           Comments:         Project Type:         FLIGHT         Solicitation / Funding MacrialsI ab Open Science Source: Campangan For Experiments on the Information Space Station and Space Station	<b>Human Research Program Elements:</b>	None		
Space Biology Cross-Element Discipline:  None  PI Email: med leark@colorado edu Fax: FY  PI Organization Type: UNIVERSITY Phone: 303-941-1008  Organization Name: University of Colorado  PI Address 1: Physics Department, CB390  PI Address 2: 2000 Colorado Ave  PI Web Page:  City: Boulder State: CO  Zip Code: 80309-0001 Congressional District: 2  Comments:  Project Type: FLIGHT Solicitation Funding Materials Lab Open Science Campaign for Experiments on the International Space Station on the International Space Station  Start Date: 12:02/2016 End Date: 12:01/2021  No. of PhD Candidates: No. of Master's Degrees: No. of PhD Candidates: No. of Master's Degrees: No. of Master's Candidates: No. of Bachelor's Degrees: No. of Sachelor's Candidates: Monitoring Center: NASA GRC  Contact Monitor: Tin, Padetha Contact Phone: 216-433-8164  Contact Email: Padethn: Tin@grc.nasa.gov  Flight Program: ISS  Flight Assignment: Liquid Crystal Facility  Key Personnel Changes/Previous PI:  COI Name (Institution): Share, Matthew Ph.D. (University of Colorado, Boulder) Park, Cheol M.S. (	Human Research Program Risks:	None		
Discipline: Space Biology Special Category: None PI Email: pole Laink@colorado.edu PI Address 1: Physics Department, CB390 PI Address 1: Physics Department, CB390 PI Address 2: 2000 Colorado Ave PI Web Page: City: Boulder State: CO Zip Code: S0309-0001 Congressional District: Comments:  FLIGHT Solicitation / Funding Materials Lab Open Science Source: No. of Path D Candidates: No. of PhD Candidates: No. of Master's Candidates: No. of Master's Candidates: No. of Bachelor's Candidates: No. of Master's Candidates: No. of Bachelor's Candidates: No. of Master's Candidates: No. of Master's Candidates: No. of Bachelor's Candidates: No. of Master's Candidates: No. of Machelor's Candidates: No. of Master's	Space Biology Element:	None		
PI Email:    No. of Past Docs:   No. of Past Docs:   No. of Past Candidates:   No. of Master's C		None		
Pl Organization Type: UNIVERSITY Phone: 303-941-1008 Organization Name: University of Colorado Pl Address 1: Physics Department, CB390 Pl Address 2: 2000 Colorado Ave Pl Web Page: City: Boulder State: CO Zip Code: 80309-0001 Congressional District: 2 Comments:  Project Type: FLIGHT Solicitation / Funding Materials.lab Open Science Campaigns for Experiments on the International Space Station of PhD Candidates: No. of PhD Degrees: No. of Post Docs: No. of PhD Degrees: No. of Master's Candidates: No. of Bachelor's Degrees: No. of Master's Candidates: No. of Bachelor's Degrees: No. of Bachelor's Candidates: No. of Bachelor's Candidates: No. of Bachelor's Candidates: No. of Bachelor's Candidates: No. of Bachelor's Degrees: No. of Master's Candidates: No. of Bachelor's Candidates:	Space Biology Special Category:	None		
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PI Address 1: Physics Department, CB390 PI Address 2: 2000 Colorado Ave PI Web Page:  City: Boulder State: CO  Zip Code: 80309-0001 Congressional District: 2  Comments:  Project Type: FLIGHT Solicitation / Funding Materials Lab Open Science Campaigns for Experiments on the International Space Station Space Station Space Station  Start Date: 12/02/2016 End Date: 12/01/2021  No. of Post Docs: No. of PhD Degrees: No. of PhD Candidates: No. of Master' Degrees: No. of Master's Candidates: No. of Master' Degrees: No. of Master's Candidates: No. of Bachelor's Degrees: No. of Bachelor's Candidates: No. of Master' Degrees: No. of Bachelor's Candidates: No. of Master' Degrees: No. of Bachelor's Candidates: No. of Master' Degrees: No. of Bachelor's Candidates: Additional Contact Phone: 216-433-8164  Contact Monitor: Tin, Padetha Contact Phone: 216-433-8164  Contact Email: Padetha. Tim@grc.nasa.gov  Flight Program: ISS  Flight Assignment: Liquid Crystal Facility  Key Personnel Changes/Previous PI:  COI Name (Institution): Glaser, Matthew Ph.D. (University of Colorado, Boulder) Park, Choel M.S. (University of Colorado, Boulder) Shuai, Min Ph.D. (University of Colorado, Boulder) Shuai, Min Ph.D. (University of Colorado, Boulder) Park, Choel M.S. (University of Colorado, Boulder) Park, Choel M.S. (University of Colorado, Boulder) Park, Choel M.S. (University of Colorado, Boulder) Park (Nouriest) of Colorado, Boulder)	PI Organization Type:	UNIVERSITY	Phone:	303-941-1008
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Zip Code: 80309-0001 Congressional District: 2  Comments:  Project Type: FLIGHT Solicitation / Funding Source: Campaigns for Experiments on the International Space Station  Start Date: 12/02/2016 End Date: 12/01/2021  No. of Post Docs: No. of PhD Degrees: No. of PhD Candidates: No. of Master's Degrees: No. of Master's Candidates: No. of Bachelor's Degrees: No. of Bachelor's Candidates: No. of Bachelor's Candidates: No. of Bachelor's Degrees: No. of Bachelor's Candidates: No. of Bachelor's Candidates: No. of Bachelor's Candidates: No. of Bachelor's Degrees: No. of PhD D	PI Web Page:			
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Project Type:  FLIGHT  Solicitation / Funding Source: Campaigns for Experiments on the International Space Station  Start Date:  12/02/2016  End Date: 12/01/2021  No. of Post Docs:  No. of PhD Degrees:  No. of PhD Degrees:  No. of PhD Candidates:  No. of Master's Candidates:  No. of Master's Candidates:  No. of Bachelor's Degrees:  No. of Bach	Comments:			
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No. of Master's Candidates:  No. of Bachelor's Degrees:  No. of Bachelor's Candidates:  Monitoring Center: NASA GRC  Contact Monitor:  Tin, Padetha  Contact Phone: 216-433-8164  Contact Email:  Padetha. Tin@grc.nasa.gov  Flight Program:  ISS  Flight Assignment:  Liquid Crystal Facility  Key Personnel Changes/Previous PI:  COI Name (Institution):  Glaser, Matthew Ph.D. (University of Colorado, Boulder) Park, Cheol M.S. (University of Colorado, Boulder) Shuai, Min Ph.D. (University of Colorado, Boulder) Park, Cheol M.S. (University of Colorado, Boulder) Shuai, Min Ph.D. (University of Colorado, Boulder) Park Colorado, Boulder)	No. of Post Docs:		No. of PhD Degrees:	
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Performance Goal No.:	COI Name (Institution):	Maclennan, Joseph Ph.D. (University of Colorado Park, Cheol M.S. (University of Colorado, Boulde	o, Boulder ) er )	
	Grant/Contract No.:	NNX17AC74G		
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Paramagnetic ferrofluids are familiar as suspensions of magnetic particles in solvents that become strongly magnetized in applied fields. A longstanding challenge has been to make such fluids ferromagnetic, so that they exhibit spontaneous macroscopic ferromagnetic ordering even in the absence of applied field. Recently, ferromagnetic fluid phases have been achieved by the ferromagnetic orientation of magnetic nanoplates in colloidal suspensions, either by dispersion in a thermotropic nematic liquid crystal host or by spontaneous nematic ordering in an isotropic solvent. These novel materials are optically birefringent, dichroic, and translucent, so that structures and textures can easily be visualized in polarized light. They manifest a variety of interesting and distinctive magnetic interaction effects and, because of the static magnetization, display ultrahigh sensitivity to externally applied magnetic fields. Field-induced changes in the shape of fluid drops, such as interfacial magnetic spike instabilities, occur even in the Earth's magnetic field and readily achievable benchtop magnetic fields are expected to induce spectacular magnetofluidic responses. Ferromagnetic nematics also exhibit distinctive magnetic self-interactions, including liquid crystal textures of fluid magnetic domains arranged in closed flux loops, that in microgravity should strongly affect the shape of free-floating drops. Freely suspended smectic LC films in the form of bubbles, the LC geometry currently studied in OASIS (Observation and Analysis of Smectic Islands in Space), will be rendered ferromagnetic by doping with magnetic nanoplates and manipulated magnetically. In suspensions studied on Earth, the typically more dense liquid crystal phase sediments to the lower parts of test cells, leaving a sharp interface with the co-existing isotropic phase. Microgravity offers the opportunity to perform critical experiments that are not possible on Earth, such as the observation of ferromagnetic droplet and other fluid interface shapes as a function of applied magnetic field, investigations of magnetic convective instabilities and thermocapillary effects resulting from temperature gradients, studies of liquid crystal ordering kinetics in the absence of gravity, and magnetic islands on smectic bubbles.

**Task Description:** 

The proposed research has both fundamental and applied aspects. One of the most interesting scientific subthemes of ferromagnetism is ferrofluidics, the study and application of paramagnetic, colloidal suspensions of sub-micron size ferromagnetic particles dispersed in solvents with random orientation of the magnetic dipoles. In ferrofluids, originally developed by NASA for enabling transport of rocket propellant in space vehicles, these nano-magnets orient in applied fields, producing a bulk magnetization that in turn generates forces and torques on the host fluid. This results in a variety of exotic and useful magneto-mechanical effects, including field-induced transport and radical changes of shape, which have led to a wide variety of technical and biomedical applications. Ferromagnetic nematics combine the traditional advantages of liquid crystal ordering with permanent magnetization, leading to delicate temperature control of the intrinsic magnetic order and a facile response to applied magnetic fields that suggests a range of enhanced applications analogous to those of conventional ferrofluids. Experiments in microgravity will enable the investigation of the fundamental properties of this new family of colloidal materials and of physical phenomena that cannot easily be probed on Earth. Microgravity investigations will be carried out using the OASIS hardware in the Materials Science Glovebox on International Space Station (ISS) with various modifications. The experiments will use the OASIS high and low resolution video cameras in their orthogonal view geometry. Magnetic freely suspended smectic bubble experiments will employ a slightly modified OASIS sample chamber. The other experiments will require new sample box designs.

**Rationale for HRP Directed Research:** 

Research Impact/Earth Benefits:

Task Progress: New project for FY2017.

Bibliography Type: Description: (Last Updated: 08/07/2023)