

Fiscal Year:	FY 2014	Task Last Updated:	FY 07/18/2014
PI Name:	Lundblad, Nathan Ph.D.		
Project Title:	Microgravity Dynamics of Bubble-Geometry Bose-Einstein Condensates		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	FUNDAMENTAL PHYSICS--Fundamental physics		
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:	FLIGHT	Solicitation / Funding Source:	2013 Fundamental Physics NNH13ZTT002N (Cold Atom Laboratory--CAL)
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No. of PhD Candidates:		No. of Master' Degrees:	
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No. of Bachelor's Candidates:		Monitoring Center:	NASA JPL
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Flight Program:	ISS		
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Aveline, David Ph.D. (Jet Propulsion Laboratory) Lannert, Courtney Ph.D. (Smith College)		
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Task Description:	<p>Notions of geometry, topology, and dimensionality have directed the historical development of quantum-gas physics. With a toolbox of forces used to confine, guide, and excite Bose-Einstein condensates (BEC) or degenerate Fermi gases (DFG), physicists have used quantum gases to test fundamental ideas in quantum theory, statistical mechanics, and in recent years notions of strongly-correlated many-body physics from the condensed-matter world.</p> <p>We propose a specific program to explore a trapping geometry for quantum gases that is both tantalizing theoretically and prohibitively difficult to attain terrestrially: a quantum gas in a bubble geometry, i.e. a trap formed by a spherical or ellipsoidal shell structure, confining a 2D quantum gas to the surface of an experimentally-controlled topologically-connected “bubble.” The physics of a quantum gas confined to such a surface has not been explored terrestrially due to the limitations of gravitational sag; interesting work has certainly been done with gases confined to the lower regions of bubble potentials, but the fully symmetric situation has yet to be explored. The low-energy excitations of such a system are unexplored, and notions of vortex creation and behavior as well as Kosterlitz-Thouless physics are tantalizing aims as well. The solid-state modeling goals of the optical-lattice physics community are also fundamentally connected to the system, as the canonical Mott-insulator/superfluid transition features superfluid shells isolated between insulating regions.</p> <p>The central method to reach the sought-after bubble-geometry BEC or DFG is that of rf or microwave dressing of the bare trapping potentials provided by the CAL “chip trap.” Radiofrequency dressing has been used conceptually through “rf-knife” evaporative cooling, but more recently through explicit construction of adiabatic potentials for interferometry, and shell-trap construction for both thermal and quantum gases. The proposed work is a window into a physical regime that is quite difficult to achieve terrestrially due to trap distortion; given the advantages of a microgravity environment, NASA CAL is uniquely positioned to realize the physics goals of this proposal.</p>
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2014.
Bibliography Type:	Description: (Last Updated: 06/20/2023)