### Project Information

**Fiscal Year:** FY 2014  
**Task Last Updated:** FY 07/18/2014

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<td>PI Name</td>
<td>Lundblad, Nathan Ph.D.</td>
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<td>Project Title</td>
<td>Microgravity Dynamics of Bubble-Geometry Bose-Einstein Condensates</td>
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<td>Division Name</td>
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<td>PI Web Page</td>
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**Key Personnel Changes/Previous PI:**

- Aveline, David Ph.D. (Jet Propulsion Laboratory)
- Lannert, Courtney Ph.D. (Smith College)

**Grant/Contract No.:** JPL 1502172

**Performance Goal No.:**

- Notions of geometry, topology, and dimensionality have directed the historical development of quantum-gas physics.
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.

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.

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.