CRC 1227
Designed Quantum States of Matter

# DQ-mat block lecture on "Quantum Gases in ring and bubble geometries", Day 2


## Brendan Rhyno

**Department of Physics,**
**University of Illinois at Urbana-Champaign**
(Guest of Dr. N. Gaaloul)


Leibniz Universität Hannover
**Room D326**
**Building 1101, Welfengarten 1**
**06 July 2023, 4.00 pm**

## "Modelling the thermodynamics of ultracold atomic bubbles in space"

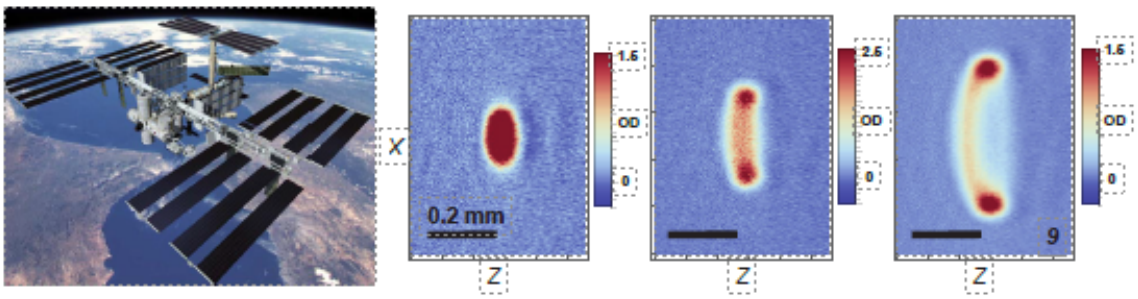

The NASA Cold Atom Lab (CAL) stationed aboard the International Space Station offers a unique platform to investigate cold atom physics in a perpetual micro-gravity environment. In particular, this setting opens up the possibility to explore quantum gases in novel shell-shaped structures. These so-called 'quantum bubbles' possess non-trivial topology which has consequences for collective mode spectra, vor-tex physics, and thermodynamics.

In this talk, I will discuss the recent observation of ultracold atomic bubbles in microgravity using CAL [1] along with our efforts to model the thermodynamic properties of shell-shaped quantum fluids [2]. I will present our methodology for calculating the Bose-Einstein condensation critical temperature in the hollowed-out bubble geometries generated on CAL and compare directly with experiment by mod-elling the temperature evolution as an initial gas is inflated into a bubble adiabatically. Employing a simplified isotropic 'bubble-trap' potential, I will address the use of standard semiclassical methods and interaction effects for quasi-2D thin shells in CAL parameter regimes.



[1] Ryan A. Carollo et al. "Observation of ultracold atomic bubbles in orbital mi-crogravity". In: Nature 606 (7913 June 2022), pp. 281–286. url: https://doi. org/10.1038/s41586-022-04639-8.

[2] Brendan Rhyno et al. "Thermodynamics in expanding shell-shaped Bose-Einstein condensates". In: Phys. Rev. A 104 (6 Dec. 2021), p. 063310. url: https : //link.aps.org/doi/10.1103/PhysRevA.104.063310.


**All DQ-mat members and all interested are cordially invited to attend.**