Vita

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Universities Attended:
University of New Brunswick (2023)
Bachelors of Science
Major in Physics & Mathematics

University of New Brunswick (2025)
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Publications /Conferences Presentations:

"A tunable frequency-offset-locked laser system for cooling neutral atomic gases" Quantum Days, Poster Presentation, University of Calgary, Calgary, Alberta, Canada, February 2024

"A tunable frequency-offset-locked laser system for matter-wave interferometry" Canadian Association of Physicists (CAP), Poster Presentation, University of New Brunswick, Fredericton, New Brunswick, Canada, June 2023

"Laser Frequency Stabilization with an Arduino" Atlantic Undergrad Physics Conference (AUPAC), St Mary's University, Halifax, Nova Scotia, Canada, February 2023

A Tunable Frequency-Offset-Locked Laser System For Cooling Neutral Atomic Gases

UNIVERSITY OF NEW BRUNSWICK

THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment

of the Requirement for the Degree of
Master of Science

by

Kamal A. Shalaby

in the Department of Physics

U.N.B., Fredericton, N.B.

Tuesday, March 4th, 2025
1:00 p.m.

Via MS TEAMs

Examining Committee

Dr. Brynle Barrett	Supervisor
Dr. Torsten Reuschel	Internal Examiner
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Abstract

Ultra-stable lasers are essential for quantum technologies, requiring precise control and agile frequency tuning. This thesis develops a modular laser locking architecture based on offset frequency locking (OFL) for a quantum gravimeter utilizing cold 87Rb atoms. Two OFL systems stabilize 1560 nm Slave lasers, frequency-doubled to 780 nm, by locking them to an ultra-stable 780 nm Master laser. From the beat frequency, the system uses a broadband frequency divider, a linear frequency-to- voltage converter, and an analog PID controller to achieve a broad locking range. We achieve a frequency-locking stability with an Allan deviation that reaches 3.10 kHz at 200 s, and a frequency agility of 250 MHz/ms. We use this system to generate sub-Doppler-cooled samples of 87Rb atoms and perform high-sensitivity spectroscopy of the 5P3/2 hyperfine excited states. These spectra enabled us to perform an absolute optical frequency calibration of the OFL system.