

IAN A. O. MACMILLAN

☎ +1 (401) 680-2531 ✉ ianaomacmillan@gmail.com 🌐 IanAMacMillan 📄 macmillani 🌐 ian-macmillan.com

EDUCATION

California Institute of Technology, *Doctor of Philosophy (PhD)*, Physics September 2019 – Present
Thesis: *Precision Control in Gravitational Physics: From LIGO to GQuEST*
Research Fields: Optimal Controls, Quantum Sensing, Laser Stabilization, Optical Cavities

Georgetown University, *Scientiae Baccalaureatum (BS)*, Physics August 2017 – May 2019
Thesis: *Brownian Thermal Noise in AlGaAs and Its Implications for LIGO's Sensitivity*
Research Fields: Optics, HR Coatings, Gravitational Waves, and Advanced Interferometry

EXPERIENCE

Graduate Researcher, California Institute of Technology October 2019 – Present
The LIGO Lab & McCuller Quantum Optics Lab

- Implemented advanced \mathcal{H}_∞ bounded LQG control for LIGO optics; reduced key noise terms by orders, boosting stability.
- Built high-finesse invacuum cavities for ultralow phase-noise laser frequency locks supporting precision imaging and spectroscopy.
- Modeled and assembled four-cavity isolator chain (about 60 dB isolation, flat passband) mitigating backreflections into sensors/camera front ends.
- Delivered spectroscopy and alignment diagnostics, CCD/photodiode analysis pipelines, and an org-wide RAG agent (Python + custom vector DB) accelerating optics and controls knowledge. (ligolabrador.com)

Optics Researcher, American University October 2016 – August 2019
LIGO Optical Development Lab

- Characterized Brownian thermal noise in amorphous and crystalline optical coatings for next-generation interferometers using ringdown techniques, contributing to the LIGO upgrade roadmap.
- Engineered and executed material testing protocols using COMSOL Multiphysics finite element analysis to optimize coating performance and predict thermal noise behavior across coating architectures.
- Achieved the first decomposition of the thermal loss angle in multilayer GaAs/AlGaAs coatings into principal components, advancing fundamental understanding of coating losses.

Visiting Research Fellow, Harvard University April 2018 – September 2018

- Developed the Overall Sky Emission Line Observing and Tracking Spectrograph (OSELOTS), a rugged field-deployed instrument for the Vera Rubin Observatory.
- Designed and implemented the full data analysis and control system architecture to optimize spectrometer performance and reliability for harsh field conditions.
- Developed and deployed custom FITS image analysis pipeline for automated detection and interpretation of astronomical data.

TECHNICAL SKILLS

Coding Languages	Python, Java, MATLAB, Mathematica, Bash, HTML, SQL, and \LaTeX
Software & Tools	COMSOL Multiphysics, FEA, SolidWorks, Inventor, Inkscape, JAMMT, Finesse, Op-toCad, Photoshop, Lightroom, and Final Cut Pro X
Controls	Optimal Modern Controls, State-Space Control, LQR/LQG, \mathcal{H}_∞ Bounded LQG, Riccati/Lyapunov Approaches, PID Controllers, and FOM Based Weighting
Optics	Interferometers, Optical Cavities, Spectrometers, Micro-Resonators, Free Space/Fiber Optics, Optomechanics, HR & AR Coatings, and CCD Cameras
Lab Equipment	FPGAs, RF Electronics, Signal Analyzers, Lock-in Amplifiers, Oscilloscopes, Power Meters, Low Noise Lasers, and Additive Manufacturing
Machine Learning	TensorFlow, Scikit-learn, Pandas, Reinforcement Learning, Agent Development, Multi-Layer RAG Development, and Vector Datastores