Clarke Hardy

PhD Candidate in Physics

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EDUCATION

PhD Candidate in Physics, *Stanford University*	2019 — PRESENT
Master of Science in Physics, *Queen's University*	2018 — 2019
Bachelor of Applied Science in Engineering, *Queen's University*	2014 — 2018

SKILLS

Languages & Computing	Python, TensorFlow, scikit-learn, pandas, C, C++, MATLAB, LabVIEW, ROOT, Git, Linux/Unix, HPC, LaTeX
CAD & Prototyping	Solidworks, Solid Edge, OrCAD, 3D printing, soldering
Simulation	COMSOL Multiphysics, Geant4, NEST, MCNP, PSpice
Hardware & Laboratory	DAQ, ultra-high vacuum, radioactive sources, cryogenics, machining, electronics
Data Science	Data processing/analysis/visualization, machine learning, image analysis, statistical modeling
Teaching	Syllabus design, course management, lesson planning, writing/grading assignments

AWARDS

NSERC Postgraduate Scholarship - Doctoral, *National Sciences and Engineering Research Council of Canada (NSERC)*	2020
Alexander Graham Bell Canada Graduate Scholarship - Doctoral, *NSERC* (declined)	2020
Clarendon Scholarship, *University of Oxford* (declined)	2019
Queen's CAP Prize Examination Award, *Queen's University*	2019
R. Samuel McLaughlin Fellowship, *Queen's University*	2018
First Place, particle physics category, *Canadian Undergraduate Physics Conference*	2017
Ontario Professional Engineers Foundation Scholarship, *Queen's University*	2015
Principal's Scholarship, *Queen's University*	2014

RESEARCH EXPERIENCE

GRADUATE RESEARCH ASSISTANT / nEXO NEUTRINOLESS DOUBLE BETA DECAY SEARCH JUN 2020 — PRESENT
Stanford University *Stanford, CA*

- Developed machine learning technique for detector light response calibration using Python & TensorFlow
- Designed xenon gas purifier to exceed radiopurity requirements using Solidworks & COMSOL Multiphysics
- Demonstrated use of ^{127}Xe for charge calibration using Stanford liquid xenon time projection chamber (TPC) test facility
- Developed software to process & analyze physics data from various test TPCs in Python & ROOT
- Designed & constructed new liquid xenon TPC test facility for Stanford lab
- Maintained & operated TPC test facilities throughout various R&D projects

GRADUATE RESEARCH ASSISTANT / LZ DARK MATTER SEARCH SEP 2019 — JUN 2020
SLAC National Accelerator Laboratory *Menlo Park, CA*

- Simulated detector response to exotic dark matter using Geant4 & NEST in ROOT
- Performed study of sensitivity to exotic dark matter using statistical tools in ROOT
- Developed software for data analysis in C++/ROOT

GRADUATE RESEARCH ASSISTANT / PICO DARK MATTER SEARCH MAY 2017 — SEP 2019
Queen's University / SNOLAB *Kingston, Canada*

- Designed, fabricated, & installed a retroreflector in the PICO-40L detector to achieve 75% increase in illuminated fraction
- Performed ray tracing simulations using MATLAB to optimize retroreflector geometry
- Designed experimental apparatus to conduct reflectivity tests for candidate retroreflector materials
- Assisted with commissioning of the PICO-40L detector at SNOLAB (underground science laboratory)
- Modelled backgrounds from coherent neutrino scattering in PICO detectors
- Determined sensitivity of the PICO-500 detector to annual modulations in a dark matter signal

UNDERGRADUATE RESEARCH ASSISTANT / NEWS-G DARK MATTER SEARCH MAY 2016 — AUG 2016
Queen's University *Kingston, Canada*

- Acquired & analyzed calibration data using a UV laser & radioactive sources
- Designed & constructed slow controls readout electronics & automated process of updating database
- Maintained & operated small test chamber & installed new larger test chamber

TEACHING EXPERIENCE

LEAD INSTRUCTOR / PHY 154: PHYSICS I WITH LAB   SEP 2022 — PRESENT
Mount Tamalpais College   *San Quentin, CA*
- Introductory course on mechanics, waves, fluids, & heat offered to students incarcerated at San Quentin State Prison
- Designed syllabus & course materials to meet specific learning outcomes
- Coordinated with instruction team to organize class meetings, study group sessions, lab activities, & distribution/grading of assignments
- Adapted to COVID-19 quarantines by switching to teaching via correspondence at multiple points during the term

CO-INSTRUCTOR / MTH 220: PRECALCULUS I   JAN 2022 — JUN 2022
Mount Tamalpais College   *San Quentin, CA*
- Precalculus course offered to students incarcerated at San Quentin State Prison
- Prepared & delivered weekly lectures; wrote & graded weekly homework assignments & exams

TEACHING ASSISTANT / PH 41: MECHANICS   JAN 2022 — MAR 2022
Stanford University   *Stanford, CA*
- Introductory calculus-based mechanics course for undergraduate students taught in a flipped classroom
- Led small groups through practice problems; held office hours; graded assignments and exams; prepared review materials

TEACHING ASSISTANT / PH 25: MODERN PHYSICS   APR 2020 — JUN 2020
Stanford University   *Stanford, CA*
- Introductory algebra-based modern physics course for undergraduate students taught on Zoom
- Led tutorial sessions to review material and work through practice problems; held office hours; graded assignments and exams

TEACHING ASSISTANT / PH 23: ELECTRICITY, MAGNETISM, & OPTICS   JAN 2020 — MAR 2020
Stanford University   *Stanford, CA*
- Introductory algebra-based electricity, magnetism & optics course for undergraduate students
- Led tutorial sessions to review material and work through practice problems; held office hours; graded assignments and exams

TEACHING ASSISTANT / APSC 111: MECHANICS   MAY 2016 — AUG 2016
Queen's University   *Kingston, Canada*
- Introductory mechanics course for first-year engineering undergraduates
- Led tutorial sessions & review sessions; graded exams

CONFERENCE PRESENTATIONS

- "Development of a ^{127}Xe calibration source for nEXO," APS April Meeting, New York City, NY, April 2022

- "Development of a high-purity zirconium purifier for nEXO," APS Division of Nuclear Physics Fall Meeting (virtual), MIT, October 2021

- "Lightmap reconstruction in nEXO with an internal xenon 127 source," Light Detection In Noble Elements (virtual), UC San Diego, September 2021

- "New Outreach Initiatives in Canada with the McDonald Institute," European Physical Society High Energy Physics Conference, Ghent, Belgium, July 2019

- "Searching for Dark Matter with PICO-40L," European Physical Society High Energy Physics Conference, Ghent, Belgium, July 2019

- "Determining the Physics Reach of the PICO Bubble Chamber Dark Matter Detectors," Canadian Association of Physicists Congress, Burnaby, Canada, June 2019

- "Improving the Optics of the PICO Bubble Chamber Dark Matter Detector," Winter Nuclear & Particle Physics Conference, Mont Tremblant, Canada, January 2018

- "Improving the Optics and Fiducial Volume of the PICO-40L Dark Matter Detector," Canadian Undergraduate Physics Conference, Ottawa, Canada, October 2017

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PUBLICATIONS

1. R.H.M. Tsang [et al., including **C.A. Hardy**], "An integrated online radioassay data storage and analytics tool for nEXO," submitted to NIM A (2023) [arXiv:2304.06180]

2. C. Adams [et al., including **C.A. Hardy**], "Neutrinoless Double Beta Decay," White Paper submitted for the Fundamental Symmetries, Neutrons, and Neutrinos Town Meeting (2022) [arXiv:2212.11099]

3. J. Aalbers [et al., including **C.A. Hardy**], "A Next-Generation Liquid Xenon Observatory for Dark Matter and Neutrino Physics," J. Phys. G: Nucl. Part. Phys. 50, 013001 (2023) [arXiv:2203.02309]

4. G. Gallina [et al., including **C. A. Hardy**], "Performance of novel VUV-sensitive Silicon Photo-Multipliers for nEXO," Eur. Phys. J. C 82, 1125 (2022) [arXiv:2209.07765]

5. B. G. Lenardo, **C. A. Hardy** et al., "Development of a ^{127}Xe calibration source for nEXO," JINST 17, P07028 (2022) [arXiv:2201.04681]

6. G Adhikari [et al., including **C A Hardy**], "nEXO: Neutrinoless double beta decay search beyond the 10^{28} year half-life sensitivity," J. Phys. G: Nucl. Part. Phys. 49, 015104 (2022) [arXiv:2106.16243]

7. D.S. Akerib [et al., including **C.A. Hardy**], "Projected sensitivities of the LUX-ZEPLIN (LZ) experiment to new physics via low-energy electron recoils," Phys. Rev. D 104, 092009 (2021) [arXiv:2102.11740]

8. M. Wagenpfeil [et al., including **C. A. Hardy**], "Reflectivity of VUV-sensitive Silicon Photomultipliers in Liquid Xenon," JINST 16, P08002 (2021) [arXiv:2104.07997]

9. M.G. Aartsen [et al., including **C. Hardy**], "Velocity independent constraints on spin-dependent DM-nucleon interactions from IceCube and PICO," Eur. Phys. J. C 80, 819 (2020) [arXiv:1907.12509]

10. C. Amole [et al., including **C. Hardy**], "Data-Driven Modelling of Electron Recoil Nucleation in PICO C_3F_8 Bubble Chambers," Phys. Rev. D 100, 082006 (2019) [arXiv:1905.12522]

11. C. Amole [et al., including **C. Hardy**], "Dark Matter Search Results from the Complete Exposure of the PICO-60 C_3F_8 Bubble Chamber," Phys. Rev. D 100, 022001 (2019) [arXiv:1902.04031]