Queen's University Experimental Astroparticle Physics Group
Summer Student Employment

APPLICATION DEADLINE: Wednesday, February 5th, 2025

The Experimental Particle Astrophysics Group at Queen's University has openings for undergraduate summer researchers in summer 2025. The group is actively involved in the design, construction, and operation of next-generation experiments that seek to answer fundamental questions in particle physics and astrophysics, including searches for dark matter particles, studies of neutrinos and neutrino properties, and investigations into advanced detector technologies. Much of our experimental work takes place at SNOLAB, the world-leading particle astrophysics laboratory located 6800' underground in Vale's Creighton mine, near Sudbury (see www.snolab.ca). Some of the summer research activities could take place at SNOLAB.

Although holding an award is not required for the positions listed below, students eligible for NSERC Undergraduate Student Research Awards ("USRAs") or other fellowship support are strongly encouraged to apply for them. Applications for USRAs and Queen's University Summer Student Research Award ("USSRAs") in Queen's Physics are coordinated by Melissa Balson (4mjb5@queensu.ca), and further information is available at https://www.queensu.ca/physics/sites/physwww/files/uploaded_files/Employment%20Ads-Students/NSERC-USRAs-2025.pdf. This year, there is a separate USSRA stream for Queen's summer research positions based at SNOLAB, which is coordinated by Stephen Sekula (stephen.sekula@queensu.ca). The application deadline for USRAs and USSRAs is February 7th, 2025.

The following experiments anticipate hiring one or more students this summer. Please send a cover letter, a cv, and a copy of a recent transcript by e-mail to the contact for each of the experiments you are interested in. Successful candidates will have strong academic records in Physics, Engineering Physics, Chemistry, or a related discipline and will have some relevant experience demonstrating potential for research.

SNO+ studies fundamental properties of neutrinos using a 780 tonne liquid scintillator target. The experiment is currently operating at SNOLAB. Potential summer research activities include data analysis, assisting in the preparation of calibration systems and calibration sources, participating in the development of tellurium process systems and procedures, and operating the detector during data taking. Queen's faculty members working on SNO+ include Mark Chen, Ryan Martin, and Alex Wright.
Contact: Alex Wright (awright@queensu.ca)

DEAP and DarkSide are large-scale liquid argon experiments that use the unique properties of liquid argon scintillation to search for extremely rare dark matter interactions. DEAP is based at SNOLAB and has already acquired 3 years' worth of data. DarkSide is a next-generation experiment, and will be the first direct dark matter experiment to fully instrument the detector with novel quantum sensors called Silicon Photomultipliers (SiPMs). Opportunities available to students include analysis of DEAP data as well as assistance with data-taking, and simulating and testing the data acquisition system for DarkSide in conjunction with colleagues at TRIUMF. There is also the opportunity for students to gain hands-on experience, using a small cryostat facility in our lab at Queen's to measure various properties of different detector materials used by DEAP and DarkSide.
Contact: Fred Schuckman (fgs@queensu.ca)

NEWS-G has developed novel spherical gas detectors that are exceptionally sensitive to low energy interactions. A large volume spherical detector has been built and is currently being installed underground at SNOLAB to search for low-mass dark matter particles and other rare low energy interactions. Prototype detectors are currently being built and tested at the Queen's NEWS-G lab. Summer positions are available to assist with the data taking at SNOLAB and Queen's, with the dark matter search and calibration data analysis, and with the development and testing of novel detector technologies.
Contact: Guillaume Giroux (gg42@queensu.ca)

PICO searches for dark matter using bubble chambers. In these detectors, the superheated liquid undergoes phase transitions when recoiling nuclei from WIMP interactions deposit energy in the fluid. These phase transitions are detected using sensitive piezo-electric transducers and video cameras. PICO-40L is the current phase of the experiment and is currently being commissioned underground at SNOLAB. The next phase of the experiment, PICO-500, is currently in the design stage. Potential summer positions include assisting with the detector operation, dark matter search and calibration data analysis, and design and testing of PICO-500 components.
Contact: Ken Clark (kjc5@queensu.ca)

HELIX (High Energy Light Isotope eXperiment) is a balloon experiment designed to measure cosmic ray light isotopes, especially the beryllium isotopes, at an altitude of ~40 km. As the Beryllium-10 isotopes are known to decay with a half-life of 5 million years, comparing the flux of this isotope with a stable isotope of Beryllium-9 can provide essential information to understand the lifetime of cosmic rays within our Galaxy. HELIX had a successful flight in 2024 summer and is preparing for the next flight. Potential summer students will work on various tasks to perform tabletop tests of the prototype detectors, data analysis and simulation for the future payload. This includes assisting the detector performance checks, data analysis, flight simulation, and R&D studies for the future detector components for the next HELIX flight.
Contact: Nahee Park (nahee.park@queensu.ca)

SBC (the Scintillating Bubble Chamber) searches for dark matter using a bubble chamber with a scintillating active fluid. Currently commissioning a test chamber at Fermilab, the dark matter detector will be installed at SNOLAB. This summer we are looking for several students to work on different areas of the project. The first is work on the molecular dynamics based simulation of interactions in the detector, and the second is the analysis of commissioning data from the first operational chamber. Finally, the integration of the data collection hardware with the computer system could be an additional task. Students interested in a more “hands on” project could be involved with the installation, commissioning, and analysis of data from a test stand at Queen’s.
Contact: Ken Clark (kjc5@queensu.ca)

nEXO is a future planned program for the study of neutrino properties, in particular for the determination of its fundamental nature and potentially its mass. Key activities in which students can become involved are the study of the application of this same detection technology to the observation of galactic supernovas, as well as the assessment of materials needed for the construction of this and other experiments. In particular, students would be involved in simulation work (supernovas) and in the assessment of special copper made by means of electroforming at SNOLAB (materials investigation).
Contact: Stephen Sekula (stephen.sekula@queensu.ca)

GeRMLab: Our lab focuses on developing germanium-based detector technologies in support of experiments to search for dark matter and neutrinoless double-beta decay such as LEGEND. We are also heavily involved in developing machine learning algorithms to support a broad range of experiments in particle astrophysics. For example, we have developed a set of tools for removing electronic noise from signals that have been applied to germanium solid-state detectors as well as gaseous proportional counters. Projects in our group will be based on a discussion with the candidate in a way to align their work with developing useful skills. Typically, projects involve a mix of hardware for collecting data and software to develop machine learning models. No prior experience in programming is required, although some familiarity with python will be advantageous. The position is open to students of all years.
Contact: Ryan Martin ryan.martin@queensu.ca

P-ONE is a newly proposed experiment to build a larger-volume neutrino telescope than IceCube in the Northeast Pacific Ocean, off the coast of Vancouver Island. The first cluster of the detector demonstrator is scheduled to be deployed in 2025. Potential summer students will work together with the group members to test and evaluate the performance of ~700 photomultiplier tubes (PMTs). The PMTs that successfully pass all tests will be sent to other P-ONE institutions for further integration with the demonstrator for future deployment. The students will work on tabletop measurements, data analysis, and data management.
Contact: Nahee Park (nahee.park@queensu.ca)

Queen's University Experimental Astroparticle Physics Group Accelerated Master's Student Opportunities for 3rd Year Students

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The Department of Physics, Engineering Physics and Astronomy offers a combined program of a BScH/MSc (Physics). This program offers an opportunity for students to carry out summer research between their 3rd and 4th years, then, in the 4th year of their Honours program (Physics) to take up to 2 courses in Physics at the graduate level which would then allow these students to enter the graduate program with advanced standing. Research begun as an undergraduate could be carried forward as a foundation for the graduate thesis, which would create an opportunity for exceptional students to complete the graduate degree within 4 terms.

KDK+ is a new experiment measuring a rare decay of 40K with openings for accelerated masters students to work on hardware, simulations and analysis.
Contact: Philippe Di Stefano (distefan@queensu.ca, https://www.queensu.ca/academia/di-stefano/)

DEAP and DarkSide are large-scale liquid argon experiments that use the unique properties of liquid argon scintillation to search for extremely rare dark matter interactions. DEAP is based at SNOLAB and has already acquired 3 years' worth of data. DarkSide is a next-generation experiment, and will be the first direct dark matter experiment to fully instrument the detector with novel quantum sensors called Silicon Photomultipliers (SiPMs). Opportunities available to students include analysis of DEAP data as well as assistance with data-taking, and simulating and testing the data acquisition system for DarkSide in conjunction with colleagues at TRIUMF. There is also the opportunity for students to gain hands-on experience, using a small cryostat facility in our lab at Queen's to measure various properties of different detector materials used by DEAP and DarkSide.
Contact: Fred Schuckman (fgs@queensu.ca)

Laboratory for Extreme Multi-Messenger Astrophysics (LEMMA) studies high-energy particles in the Universe. Our Universe harbours an enormous number of objects capable of accelerating charged particles to energies much higher than anything that can be obtained by human-made accelerators. LEMMA aims to identify these extreme accelerators in our Universe by combining the knowledge gained from observations of many different particle messengers: cosmic rays, high-energy gamma rays, and high-energy neutrinos.
Webpage: https://www.queensu.ca/physics/lemma/

LEMMA Research opportunities:
HELIX (High Energy Light Isotope eXperiment): HELIX is a NASA-funded balloon experiment. The payload is designed to measure the fluxes of cosmic ray isotopes, which will provide unique data to study the propagation of cosmic rays in our Galaxy. HELIX has a successful flight in 2024 summer. Research opportunities with HELIX will be focused on developing and evaluating the Monte Carlo detector simulation to study the flight data. This will require skills in computer programming to perform the data analysis and understanding of statistical analysis.

P-ONE (Pacific Ocean Neutrino Experiment) is a proposed high-energy neutrino telescope located off the coast of Vancouver Island. The scientific motivation of the experiment is to measure the high-energy neutrinos and search for the origin of these neutrinos. The first Demonstrator string is scheduled to be deployed in 2025. The research opportunity with P-ONE is to characterize the photomultiplier tubes (PMTs), a sensitive photon detector, that will be assembled for the Demonstrator. This will involve setting up the apparatus for various tests, building an automated testing environment, testing hundreds of PMTs, and data analysis. Depending on the progress, the research may include the high-energy neutrino telescope simulation to study the properties of P-ONE with different string configurations.
Contact: Nahee Park (nahee.park@queensu.ca)