PHYSICS, ENGINEERING PHYSICS AND ASTRONOMY

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Departmental Facilities

The Department of Physics, Engineering Physics and Astronomy is located in Stirling Hall on Bader Lane. This teaching and research centre houses facilities for investigations in astronomy and astrophysics, condensed matter and low-temperature physics, engineering and applied physics, and sub-atomic physics. In addition, research is conducted at a number of external facilities.

Most of the observational work in radio astronomy is done with the Very Large Array (VLA) of the NRAO near Socorro, New Mexico and the James Clerk Maxwell Telescope in Hawaii. Optical and infrared observations are carried out at the Canada-France-Hawaii Telescope, the National Optical Astronomy Observatories, the Gemini Telescope, Lick Observatory, the Anglo-Australian Telescope, and other international facilities, including the Hubble Space Telescope. Astrophysical theorists work in the areas of general relativity, physical cosmology, high energy and particle astrophysics, star formation, and solar system dynamics. For more information, see the separate calendar entry under Astronomy and Astrophysics.

Research in many areas of condensed matter, low-temperature, and applied physics is carried out using a wide variety of equipment. Access to very low temperatures is provided by a facility for reaching millikelvin temperatures, which is unique to Canada. The Applied Magnetics group has extensive industrial collaboration, a large number of highly innovative test rigs and a major investment in state-of-the-art finite element field-computational software. The Applied Solid State Physics group has extensive facilities for physical and chemical deposition of thin films and for microcircuit development of novel circuits integrated into silicon. The electronic states on semiconductor surfaces are studied using a high-resolution inverse photoemission spectrometer. The geometry of semiconductor surfaces is studied, at the atomic level, using electron emission holography and scanning tunnelling microscopy. The properties of two-dimensional electron gas systems over a wide range of temperature and magnetic fields are studied by precision measurements of transport properties. Data at very high magnetic fields are obtained using facilities at Nijmegen, The Netherlands. X-ray and optical experiments are used to investigate phase transitions in polymer blends and crystals with magnetic and structural disorder. This research also makes use of X-ray and neutron scattering facilities at Brookhaven and Chalk River. At the Kingston General Hospital, X-ray, gamma-ray and electron beam sources are used in investigations of ionizing radiation in various types of tissue, and the MRI scanner is used in various projects related to imaging. Nanoscale electronic and mechanical devices are fabricated using electron-beam lothography. These devices are cooled to cryogenic temperatures and studied with precision radio frequency techniques.

The research program of the experimental subatomic physics group at Queen's focuses on particle astrophysics, in particular neutrino physics and astrophysics, and dark matter detection. The experimental work takes place at the Sudbury Neutrino Observatory (SNO) and the newly expanded underground laboratory known as SNOLAB. SNO is a solar neutrino detector currently taking data in its third and final operational phase. Its unique capability of measuring the total flux of all neutrino flavours from the Sun along with the electron flavour component enables SNO to examine fundamental neutrino properties such as neutrino mass, mixing and flavour oscillations. By studying the neutrino flux from the Sun, details of the solar interior, such as the central temperature, are also being probed, allowing stringent tests of solar models. The Queen's group is actively involved in data analysis and has responsibility for the calibrations of the SNO detector. In addition to SNO, Queen's researchers are active in the development the next generation of experiments in particle astrophysics for SNOLAB. Researchers participating in the PICASSO and DEAP projects at Queen's are developing technologies and experiments for dark matter detection, with operational prototypes being installed in SNOLAB in the current and upcoming few years. Researchers at Queen's are developing the follow-up experiment to SNO, known as SNO+. A large liquid scintillator detector, SNO+ will continue to make precision measurements of fundamental neutrino properties, probing the nature of the neutrino-matter interaction and SNO+ will study geo-neutrinos, the neutrinos emitted by radioactivity in the Earth, contributing valuable new information in the field of geophysics. Researchers at Queen's are also involved in the Majorana double beta decay experiment, the next-generation experiment employing enriched germanium detectors, searching for evidence of neutrinoless double beta decay, and thus probing neutrino mass at very low (and interesting) energy scales. Facilities at Queen's that support this research include clean rooms for assembling low background detectors, mechanical and electrical technical support, and computing.

Research facilities are supported by many computers and work-stations in the department, and by large computers in the University Computing Centre.

The department maintains a well-equipped instrument shop.

Financial Assistance

Graduate students are normally supported by various assistantships and scholarships. Students holding external awards (eg. NSERC or OGS) are offered additional support. Please contact the department for details.

Fields of Research

Research in the Department of Physics, Engineering Physics & Astronomy aims to understand basic physical processes that underlie the structure of the universe, stars and galaxies, and of matter. Work in the department also seeks to leverage that understanding to improve human physical and economic well-being.

Research groups in the department include:

Astronomy, Astrophysics, and Relativity. Research in this area ranges from the solar system, to stars, the interstellar medium, the structure and formation of galaxies, and the structure and evolution of the universe. See https://www.queensu.ca/physics/research-groups/astronomy-astrophysics-relativity (https://www.queensu.ca/physics/research-groups/astronomy-astrophysics-relativity/)

Condensed Matter Physics and Optics. Research in this area probes the structure and behavior of matter from molecules, to quantum dots, to hard and soft condensed matter systems. Research in this area also studies light-matter interaction via theory, and experiments in ultrafast, nonlinear, and quantum optics. See https://www.queensu.ca/physics/research-groups/condensed-matter-physics-optics (https://www.queensu.ca/physics/research-groups/condensed-matter-physics-optics/)

Engineering and Applied Physics. Research in this area spans a broad array of topics, both theoretical and experimental, including the physics of materials, clinical cancer care, nanophotonics, renewable energy, device physics, complex systems, and industrial design. See https://www.queensu.ca/physics/research-groups/engineering-applied-physics (https://www.queensu.ca/physics/research-groups/engineering-applied-physics/)

Particle Astrophysics. Theoretical and experimental research in this area probes such questions as: What is the nature of dark matter and dark energy? How have the properties of particles, like the neutrino, shaped the evolution of the universe? What are cosmic rays and what accelerates them? Are protons stable? Are there additional spacetime dimensions? See https://www.queensu.ca/physics/research-groups/particle-astrophysics (https://www.queensu.ca/physics/research-groups/particle-astrophysics/)

For further information on our graduate programs, please go to: https://www.queensu.ca/physics/grad-studies/applicants (https://www.queensu.ca/physics/grad-studies/applicants/)

Materials Science and Technology

The Department cooperates with the Departments of Chemical Engineering, Chemistry, Electrical and Computer Engineering, and Mechanical and Materials Engineering in offering courses and research projects to students wishing to concentrate in materials science and technology. Students are registered for MSc and PhD degrees in one of these five departments and are encouraged to take relevant courses from the others.