

**F**ounded in 1904, the Department of Physics (Physics and Astronomy in 1998) is one of the most active research units in the Science Faculty, currently with 22 faculty active in various areas of experimental and theoretical physics. The current level of grant support is over \$1.6 million - significantly above the national average in the disciplines involved. A broad spectrum of research in both fundamental and applied physics is carried out in laboratories at the University of Manitoba and at international facilities around the world. Typically, about 40 graduate students (50% M.Sc. and 50% Ph.D.) and 15-20 post-doctoral fellows/research associates, as well as over 20 Adjunct Professors are involved in the program.

### Programs and Research

Astrophysics is one of the most exciting areas in Physics as it allows the study of the origin, evolution, and fate of our Universe. Our research program addresses observational and theoretical investigations of the building blocks of the Universe from planets to stars to galaxies. Observations are conducted with state-of-the-art international telescopes that cover

the electromagnetic spectrum from radio wavelengths to infrared and optical to X-rays. Such investigations at the University of Manitoba are more specifically targeted to study dark matter in galaxies and the physics of neutron stars, supernova remnants and their interaction with the Interstellar Medium. Theoretical investigations make use of powerful computational techniques to study a variety of astrophysical phenomena including star formation, and planetary physics.



Atomic, Molecular and Optical science focuses on the properties of the common building blocks around us - namely, atoms, molecules and light. By examining the structure and interactions between atoms and molecules, and their interaction with light, AMO physics increases our fundamental understanding of nature. It is also a powerful "enabling" science that has led to developments important to research and industry (e.g., the laser). Current research makes use of modern laser systems and spectroscopic equipment to investigate new physical phenomena at the atomic level.

Soft condensed matter and biological physics is the most rapidly growing area of physics. Our research programs exemplify the diversity that makes this field so exciting. Interests include the mesoscale physics of novel wave phenomena in complex structured materials, studying large biomolecules using time-of-flight mass spectrometry and its pivotal role in proteomics, understanding the electronic properties of DNA with a view to future applications in nanoscale bio-electronics, and developing theoretical models of polymers and lipids.

The study of condensed matter continues to be the largest branch of physics. Current research directions are in nanoscale physics, magnetism in nanoscale systems, and novel magnetic properties induced by various kinds of disorder. Phase transitions and magnetic excitations in multi-dimensional systems are also of key interest.

The subatomic physics group has a diverse experimental program based at major international facilities. Precision measurements are undertaken to test the Standard Model of nature's fundamental interactions and to elucidate subtle aspects of the structure of nucleons and nuclei. Theoretical efforts are geared towards understanding such things as nuclear structure and electron scattering using relativistic many-body theory.

The multidisciplinary Medical Physics research programs are primarily focused on addressing problems in Diagnostic Imaging and Radiation Oncology. Exciting and award winning research is being carried out in such diverse areas as: breast imaging using MR, microwaves and x-ray scattering, portal image dosimetry and treatment verification, image processing, radiation therapy treatment delivery optimisation, spectroscopic MRI, stereotactic radiosurgery, and the modeling, simulation and analysis of radiation transport.

A principle goal of theoretical physics research is to achieve a unification of classical and quantum mechanics in a common mathematical framework. The theory that emerges is called a quantum phase space and is an altered version of classical phase space. Current work aims at incorporating the full structure of general relativity and non-Abelian gauge theory into the quantum phase space picture.

### Affiliations with Organizations / Community

Many of the academic faculty have established significant research facilities in the department, including electron microscopes, several high-resolution mass spectrometers, a helium liquefier, a dilution refrigerator for millikelvin temperatures, an ultrasonics research laboratory, and extensive computer facilities. Research is also conducted at major international facilities such as TRIUMF (Vancouver), Argonne and Los Alamos National Laboratories (USA), and Jefferson Lab (USA), while others make use of data from

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major observatories such as the Hubble space telescope and NASA's Chandra X-ray satellite. Medical physics research is conducted at CancerCare Manitoba and at the NRC Institute for Biomedical Research. A High Performance Computing Facility at the University of Manitoba is utilized for theoretical simulation studies of phase transitions in condensed matter systems.

### Admissions Information

To enter the Master's program directly a student must have an Honours B.Sc. degree in Physics, Mathematics and Physics, or Engineering Physics from the University of Manitoba or equivalent. Normally, students must complete an M.Sc. degree before entering the Ph.D. program. However, students with an Honours degree from the University of Manitoba or equivalent may, at their supervisor's discretion, be accepted directly into the Ph.D. program. International students are strongly encouraged to write the GRE Physics subject examination before their initial registration. International students applying for either the M.Sc. or Ph.D. program in Physics are required to write and obtain a minimum score of 550 (or 213

on the computerized test) on the TOEFL English proficiency test.

### Funding Opportunities

In addition to the fellowships and scholarships described in the Faculty of Graduate Studies, graduate students in the Department of Physics and Astronomy receive a stipend (the stipends are currently \$15,300/year for M.Sc. students; \$16,300/year for Ph.D. students) from their advisor's research grant. Teaching Assistant positions are also available (typically \$2000/year); a good command of the English language is required to be eligible for these positions.



## About the University of Manitoba

The University of Manitoba (est. 1877) is the largest, most comprehensive and only research-intensive post-secondary educational institution in Manitoba. The University attracts the brightest students and Faculty from around the world. Located in the heart of Canada, Winnipeg is one of the most culturally diverse cities in the country with nearly 100 languages represented.

Winnipeg's climate of four contrasting seasons provides a multitude of outdoor activities to be explored. The campus is fully networked, and hosts over 40 Research Centres and Institutes. The 13 branch Research Library Facility ensures all of the information you need for your studies is at your fingertips. Access to reasonably-priced on- and off-campus housing makes the U of M one of the most affordable universities to study at in Canada.

The University of Manitoba (U of M) attracts exceptional scholars to its 18 Faculties and 4 Schools and provides a world-class education in the Social, Medical, Natural and Applied Sciences, as well as Engineering, the Arts and Humanities. Programming in over 80 disciplines at the graduate level lead to 82 Master's degrees and 51 Ph.D.'s including: business management, engineering, agricultural and nutritional sciences, social sciences and humanities, education, physical

and earth sciences, medical and life sciences and exciting interdisciplinary opportunities. International students at the U of M have exclusive graduate funding opportunities available throughout their graduate program including entrance scholarships, bursaries and graduate fellowships.



An aerial view of the Fort Garry campus of the University of Manitoba, situated on a bow of the Red River.