Physics

trentu.ca/physics

Associate Professor and Chair of the Department of Physics & Astronomy

R. Wortis, BSc (Harvard), MSc, PhD (Illinois)

Professors

W. A. Atkinson, MSc (Alberta), PhD (McMaster) (on leave Fall 2019)
S. Narine, BSc, MSc (Trent), PhD (Guelph)
D. R. Patton, BMath (Waterloo), PhD (Victoria)

Associate Professor and Canada Research Chair

A. D. Slepkov, BSc (Brock), MSc, PhD (Alberta)

Associate Professor

R. C. Shiell, BA Physics (Oxford), PhD (Newcastle upon Tyne)

Physics is the most fundamental of the natural sciences. It includes the study of electricity and magnetism, gravitation, electronics, the motion of projectiles and rotating bodies, heat, light and sound, and the interactions between the smallest particles that make up matter: electrons, protons, neutrons, and quarks. Because of their fundamental nature, the concepts of physics underlie much of modern astronomy, chemistry, biology, medicine, and engineering. In particular, the traditional route to becoming an astronomer has been through an undergraduate degree in physics. Discoveries in physics and astronomy continue to broaden our understanding of the universe, advance space travel, speed up global electronic communications, lead to new products such as ferroelectric computer memories, assist forensic science, and improve medical diagnostic techniques.

Notes

- For the programs in Chemical Physics, Computing Systems & Physics, and Mathematical Physics, see the relevant sections of the Calendar.
- 60% or higher in MATH 1120H is required for upper-level Physics courses.
- The Honours program satisfies the academic requirements for the Professional Physicist credential by the Canadian Association of Physicists.

Bachelor of Science Program in Physics

- In addition to the program requirements listed below, students must satisfy the University degree requirements (see p. 14).
- A cross-listed course can count only once toward the required numbers of credits within a joint-major or major-and-minor degree.
- MATH 1550H is strongly recommended for students in the Honours program; MATH 1350H is a prerequisite for upper-level Mathematics courses.

The single-major Honours program. 20.0 credits including the following 12.5 credits:

- 7.5 PHYS credits consisting of PHYS 1001H, 1002H, 2150H, 2610H, 2620H, 2700H, 3130H, 3150H, 3200Y, 3610H and 4610H (or 4600Y), 4220H, 4140H (or 3140H), and 4700H
- 1.0 PHYS credit at the 4000 level in addition to the above
- 1.5 PHYS credits in addition to the above
- 2.0 MATH credits consisting of MATH 1110H, 1120H, 2110H, and 2120H
- 0.5 COIS credit consisting of COIS 1020H
- 14.0 science credits are required for the Honours degree

The joint-major Honours program. 20.0 credits including the following 9.0 credits:

- 6.0 PHYS credits consisting of PHYS 1001H, 1002H, 2150H, 2610H, 2620H, 2700H, 3130H, 3150H, 3200Y, 3610H and 4610H (or 4600Y)
- 0.5 PHYS credit at the 4000 level in addition to the above, or PHYS 4140H (or 3140H)
- 2.0 MATH credits consisting of MATH 1110H, 1120H, 2110H, and 2120H
- 0.5 COIS credit consisting of COIS 1020H
- 14.0 science credits are required for the Honours degree

The single-major General program. 15.0 credits including the following 8.0 credits:

- 4.5 PHYS credits consisting of PHYS 1001H, 1002H, 2150H, 2610H, 2620H, 2700H, 3130H, and 3200Y
- 1.0 PHYS credit in addition to the above
- 2.0 MATH credits consisting of MATH 1110H, 1120H, 2110H, and 2120H
- 0.5 COIS credit consisting of COIS 1020H
- 11.0 science credits are required for the General degree

The joint-major General program. 15.0 credits including the following 7.0 credits:

- 4.5 PHYS credits consisting of PHYS 1001H, 1002H, 2150H, 2610H, 2620H, 2700H, 3130H, and 3200Y
- 2.0 MATH credits consisting of MATH 1110H, 1120H, 2110H, and 2120H
- 0.5 COIS credit consisting of COIS 1020H
- 11.0 science credits are required for the General degree

The minor in Physics consists of the following 7.0 credits:

- 4.5 PHYS credits consisting of PHYS 1001H, 1002H, 2150H, 2610H, 2620H, 2700H, 3130H, and 3200Y
- 2.0 MATH credits consisting of MATH 1110H, 1120H, 2110H, and 2120H
- 0.5 COIS credit consisting of COIS 1020H

Please consult the academic timetable for information on courses that will be offered in 2019–2020, including when they will be scheduled.

» **PHYS 1001H: Introductory Physics I (Sc)**
Topics include kinematics, dynamics, translational and rotational motion, fluids, elasticity, and thermal physics. Prerequisite: 4U Advanced Functions or equivalent, or permission of the department. Strongly recommended: 4U credits in Physics, and Calculus and Vectors. MATH 1110H, required for upper-level Physics courses, recommended to be taken concurrently with PHYS 1001H. Excludes PHYS 1000Y, PHYS-FRSC 1020H.

» **PHYS 1002H: Introductory Physics II (Sc)**
Topics include electrostatics, magnetostatics, electromagnetism, optics, and quantum physics. Prerequisite: PHYS 1001H or 1020H or permission of the department. MATH 1120H, required for upper-level Physics courses, recommended to be taken concurrently with PHYS 1002H. Excludes PHYS 1000Y.

» **PHYS-BIOL 1060H: Physics for the Life Sciences (Sc)**
The application of basic physical concepts to biological systems. Topics include forces and motion, energy and metabolism, thermodynamics, and fluid dynamics. Recommended: 4U Math. Not for credit toward a major or minor in Physics.

» **PHYS 1510H: Introductory Astronomy I (Sc)**
A general science course accessible to all students. Topics include sky phenomena, the history of astronomy, telescopes and detectors, and an exploration of the Solar System. Excludes PHYS 1500Y. Not for credit toward a major or minor in Physics.

» **PHYS 1520H: Introductory Astronomy II (Sc)**
A general science course accessible to all students. Topics include stars, their properties, structure, and evolution, white dwarfs, novae and supernovae, neutron stars, black holes, galaxies, and cosmology. Prerequisite: PHYS 1510H. Excludes PHYS 1500Y. Not for credit toward a major or minor in Physics.

» **PHYS-EDUC 2091H: Light and Colour for Future Teachers**
An experiential learning course designed for future elementary school teachers. Topics include image formation, colour perception, reflection, refraction, shadows, and printing. Emphasis is placed on student learning through collaborative experiments and construction of conceptual models. Registration preference is given to students in education programs, but students in other programs are also welcome. Can be taken either before or after PHYS-EDUC 2093H. Does not satisfy the science requirement for a science degree. Not open to students enrolled in or with credit for PHYS 1001H, 1002H, 1020H, or 1060H, except by permission of the instructor. Excludes PHYS 2090Y.

» **PHYS-EDUC 2093H: Electricity and Motion for Future Teachers**
An experiential learning course designed for future elementary school teachers. Topics include simple circuits and circuit elements, static electricity, forces, pulleys, levers, and gears. Emphasis is placed on student learning through collaborative experiments and construction of conceptual models. Registration preference is given to students in education programs, but students in other programs are also welcome. Can be taken either before or after PHYS-EDUC 2091H. Does not satisfy the science requirement for a science degree. Not open to students enrolled in or with credit for PHYS 1001H, 1002H, 1020H, or 1060H, except by permission of the instructor. Excludes PHYS 2090Y.

» **PHYS-MATH 2150H: Ordinary Differential Equations (Sc) (see Mathematics)**

» **PHYS-COIS 2250H: Electronics (Sc)**
An applied course in the electronic circuits most commonly used in laboratory sciences. Circuit theory, test instruments, operational amplifiers, semiconductor theory, measurement sensors, power control, digital circuits, computer process-control and data collection, AC circuit theory, filters, DC power supplies, RC timing circuits, amplifiers, oscillators. Prerequisite: 60% or higher in PHYS 1002H and in MATH 1120H, or permission of the department.

» **PHYS-COIS 2310H: Computational Physics (Sc)**
Use of computational methods to solve a range of problems in physics that are not accessible to analytical treatment. Typical topics include the motion of real projectiles, planetary motion and chaos, electric fields, waves, and random systems. Prerequisite: 60% or higher in each of PHYS 1002H, MATH 1120H, and COIS 1020H, or permission of the department.

» **PHYS 2610H: Introductory Quantum Physics (Sc)**
Special relativity, particle-like aspects of radiation, atomic structure, wave-like properties of matter, Schrodinger equation and applications to one-dimensional systems. Prerequisite: 60% or higher in PHYS 1002H and in MATH 1120H, or permission of the department. Pre- or co-requisite: PHYS-MATH 2150H.

» **PHYS 2620H: Atomic, Molecular, and Nuclear Physics (Sc)**
Quantum mechanics of one-electron atoms, magnetic dipole moments and spin, transitions and selection rules, identical particles, excited states of atoms, molecules, nuclear and particle physics. Prerequisite: PHYS 2610H, PHYS-MATH 2150H, and MATH 2110H.

» **PHYS 2700H: Thermal Physics (Sc)**
The laws of thermodynamics and their applications, thermodynamic potentials, kinetic theory of gases, introduction to statistical thermodynamics. Prerequisite: PHYS 2610H and MATH 2110H.

» **PHYS-MATH 3130H: Classical Mechanics (Sc)**
Classical mechanics of particles in three dimensions. Topics include Newtonian mechanics, oscillations, motion in non-inertial reference frames, gravity, and central forces. Prerequisite: 60% or higher in PHYS 1002H and in MATH 1120H, or permission of the department. Pre- or co-requisite: MATH 2110H and 2150H.

» **PHYS-MATH 3150H: Partial Differential Equations (Sc) (see Mathematics)**

» **PHYS-MATH 3160H: Methods of Applied Mathematics (Sc) (see Mathematics)**

» **PHYS-COIS 3200Y: Electricity and Magnetism (Sc)**
Electrostatics, magnetostatics, electric and magnetic properties of matter, Maxwell's equations, electromagnetic wave propagation. Prerequisite: 60% or higher in PHYS 1002H or permission of the department; PHYS-MATH 2150H, MATH 2110H, and 2120H.

» **PHYS-BIOL 3510H: Astrobiology: Life in the Universe (Sc)**
An examination of the prospects for extraterrestrial life, based primarily on material from astronomy, biology, and planetary science. Topics include the origin and evolution of life on Earth, extremophiles, the habitability of Mars and Jovian moons, the nature and habitability of exoplanets, SETI, the Drake equation, and the Fermi paradox. Prerequisite: 5.0 university credits including two of BIOL 1020H, BIOL 1030H, PHYS 1510H, or PHYS 1520H. Excludes PHYS 2510H. Not for credit toward a major or minor in Physics.

» **PHYS 3610H: Foundations of Quantum Mechanics (Sc)**
An introduction to the foundations of quantum mechanics. Topics include the postulates of quantum mechanics, Hilbert spaces, Dirac notation, one dimensional problems, matrix representations of quantum mechanics, unitary transformations. Prerequisite: PHYS 2620H and PHYS-MATH 2150H. Recommended: MATH 2350H. Excludes PHYS 4600Y.

» **PHYS 3900Y, 3901H: Reading Course (Sc)**
Designed to allow advanced students in Physics to pursue independent study under the direction of departmental faculty. Available only in exceptional circumstances and with the approval of the department.

» **PHYS 4000Y/4010H: Project Course (Sc)**
An experimental or theoretical project on some topic of advanced physics. Projects are selected in consultation with Physics & Astronomy faculty. Students must obtain approval for the project. Contact the department office for an application form. A cumulative average of at least 77% in all PHYS and MATH credits will normally be required. Students may take only one of PHYS 4000Y or 4010H for credit.

» **PHYS 4050H: Advanced Experimental Techniques (Sc)**
Instructs students in techniques commonly found within research laboratories and industrial workplaces, such as principal component analysis, microcontroller programming, analysis of control systems, and interferometry. Pre- or co-requisite: PHYS-COIS 2250H.

» **PHYS-MATH 4140H: Advanced Classical Mechanics (Sc)**
Classical mechanics of particles, rigid bodies, and continuous media. Topics include Lagrangian and Hamiltonian mechanics, systems of particles, motion of rigid bodies, and oscillating systems. Prerequisite: MATH 2110H, 2150H, and PHYS-MATH 3130H. Excludes PHYS-MATH 3140H.

» **PHYS 4220H: Electromagnetic Theory (Sc)**
Maxwell's equations, the interactions of electromagnetic fields with matter, the relativistic formulation of electromagnetism and its applications. Prerequisite: PHYS-COIS 3200Y and PHYS-MATH 3150H.

» **PHYS 4240H: Modern Optics (Sc)**
Properties of light: polarization, interference, coherence, and diffraction. Interaction of light with matter: Einstein coefficients and quantum-mechanical treatment of matter. Laser operation and applications: absorption, gain, and saturation; three and four-level laser systems; longitudinal and transverse modes; specific laser systems. Concepts in modern quantum optics. Pre- or co-requisite: PHYS 2620H, PHYS-COIS 3200Y, and PHYS-MATH 3150H.

» **PHYS 4310H: Condensed Matter Physics (Sc)**
Crystallography, crystal binding, lattice vibrations and thermal properties of solids, band theory, electron transport, semiconductors, magnetism. Prerequisite: PHYS 2700H and 2620H. Pre- or co-requisite: PHYS-COIS 3200Y and PHYS-MATH 3150H.

» **PHYS 4520H: Astrophysics: Galaxies and Cosmology (Sc)**
An introduction to modern astrophysics, which applies the principles of physics to the study of galaxies and cosmology. Topics include the Milky Way galaxy, the nature of galaxies, galaxy evolution, the structure of the universe, active galactic nuclei and quasars, cosmology, and the early universe. Prerequisite: PHYS 2620H. Strongly recommended: PHYS 1510H and 1520H.

» **PHYS 4610H: Advanced Quantum Mechanics (Sc)**
Advanced topics in quantum mechanics. Spherically symmetric potentials, theory of angular momentum, perturbation theory, selected special topics. Prerequisite: PHYS 3610H and MATH 3150H. Recommended: MATH 2350H. Excludes PHYS 4600Y.

» **PHYS 4700H: Statistical and Thermal Physics (Sc)**
The statistical meaning of entropy and temperature; microcanonical, canonical, and grand canonical ensembles; derivation of distributions for distinguishable and indistinguishable particles and applications. Additional topics may include advanced methods in classical statistical mechanics, an introduction to phase transitions, and cryogenics. Prerequisite: PHYS 2620H, 2700H, and MATH 2110H. Pre- or co-requisite: PHYS-MATH 3150H.

» **PHYS 4900Y, 4901H, 4902H: Reading Course (Sc)**
Designed to allow advanced students in Physics to pursue independent study under the direction of departmental faculty. Available only in exceptional circumstances, and with the approval of the department.