

## Twin Cities Campus

Physics Ph.D. School of Physics & Astronomy College of Science and Engineering

Link to a list of faculty for this program.

### **Contact Information:**

Director of Graduate Studies in Physics, School of Physics and Astronomy, University of Minnesota, 116 Church St. SE, Minneapolis, MN 55455 (612-626-5982; fax: 612-624-4578) Email: <u>grad@physics.umn.edu</u> Website: <u>http://www.physics.umn.edu/grad</u>

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- Length of program in credits: 64
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the <u>General Information</u> section of the catalog website for requirements that apply to all major fields.

Physics is the study of the fundamental structure and interactions of matter. Research areas in the program include experimental and theoretical studies in astrophysics and cosmology, biological physics, condensed matter physics, elementary particle physics, nuclear physics, space and planetary physics, and physics education research. Interdisciplinary study is also available with the programs in astrophysics, biological sciences, chemistry, chemical engineering and materials science, electrical and computer engineering, mechanical engineering, and the history of science and technology.

## **Program Delivery**

This program is available:

• via classroom (the majority of instruction is face-to-face)

## Prerequisites for Admission

The preferred undergraduate GPA for admittance to the program is 3.50.

Other requirements to be completed before admission:

Teaching assistantships and a few fellowships are available upon admittance to the School of Physics and Astronomy.

Applicants are required to submit three letters of recommendation from persons familiar with their scholarship and research potential; a complete set of transcripts; and a clearly written statement of career interests, goals, and objectives. Submission of GRE scores is strongly recommended. Fall semester entry is strongly recommended for all students. Application by December 15 is strongly encouraged to ensure priority consideration for fellowships awarded for the next academic year. Additional application information is available at http://www.physics.umn.edu/grad/physics/application.html

#### **Special Application Requirements:**

Courses at the upper division level in the core areas of classical mechanics, electricity and magnetism, quantum mechanics, and statistical and thermal physics are required. It is advisable to have taken an upper division course in experimental methods in physics.

International applicants must submit score(s) from one of the following tests:

- TOEFL
- Internet Based Total Score: 79
- Internet Based Writing Score: 21
- Internet Based Reading Score: 19
- Paper Based Total Score: 55
- IELTS
- Total Score: 6.5
- MELAB
- Final score: 80

Key to test abbreviations(TOEFL, IELTS, MELAB).



For an online application or for more information about graduate education admissions, see the <u>General Information</u> section of the catalog website.

# Program Requirements

40 credits are required in the major.0 credits are required outside the major.24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.30 is required for students to remain in good standing.

Physics 4001, 4002, 4101, 4201, and 4303 cannot be used to satisfy the requirements.

Students whose financial support comes from TA assignments are also required to complete 3 credits of PHYS 5072 over two semesters. These credits count towards elective requirements.

Required orientation: Before the beginning of fall semester, new graduate students are expected to participate in the department orientation program. This includes TA orientation sessions, which are required if a student's financial support comes from TA assignments.

Requirement for international students: International students who want to teach as TAs must take CSE TALK, a workshop on American teaching culture and language skills, prior to the department orientation described above and achieve an ELP (English Language Proficiency) rating of 1. This includes passing an English test, which is given in late July and August. Students who do not achieve an ELP of 1 must take an English training course geared to their level of skills, such as GRAD 5105, GRAD 5102, or Foundations. These courses are given during the academic year and are required until the student achieves an ELP of 1.

#### **Required Courses**

- PHYS 5001 Quantum Mechanics I (4.0 cr)
- PHYS 5002 Quantum Mechanics II (4.0 cr)
- PHYS 5011 Classical Physics I (4.0 cr)
- PHYS 5012 Classical Physics II (4.0 cr)
- PHYS 5201 Thermal and Statistical Physics (3.0 cr)

#### Seminars

Take 2 or more course(s) totaling 2 or more credit(s) from the following:

- •PHYS 8100 Seminar: Problems of Physics Teaching and Higher Education (1.0 cr)
- •PHYS 8200 Seminar: Cosmology and High Energy Astrophysics (1.0 cr)
- •PHYS 8300 Seminar: Biological and Medical Physics. (1.0 cr)
- •PHYS 8600 Seminar: Space Physics (1.0 cr)
- •PHYS 8700 Seminar: Condensed Matter Physics (1.0 cr)
- •PHYS 8800 Seminar: Nuclear Physics (1.0 cr)
- •PHYS 8900 Seminar: Elementary Particle Physics (1.0 cr)

#### Electives

Students may choose courses from this list or consult with their advisor for additional options.

Take 19 or more credit(s) from the following:

#### Atomic Physics and Optics

•PHYS 8161 - Atomic and Molecular Structure (3.0 cr)

## •Biophysics and Medical Physics

•PHYS 5081 - Introduction to Biopolymer Physics (3.0 cr)

- PHYS 5401 Physiological Physics (4.0 cr)
- PHYS 5402 Radiological Physics (4.0 cr)
- PHYS 8311 Biological Physics of Single Molecules (3.0 cr)
- PHYS 8312 Biological Physics of Macroscopic Systems (3.0 cr)
- PHYS 8300 Seminar: Biological and Medical Physics. (1.0 cr)

### •Condensed Matter Physics

- •PHYS 4211 Introduction to Solid-State Physics (3.0 cr)
- PHYS 5701 Solid-State Physics for Engineers and Scientists (4.0 cr)
- PHYS 8702 Statistical Mechanics and Transport Theory (3.0 cr)
- PHYS 8711 Solid-State Physics I (3.0 cr)

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PHYS 8712 - Solid-State Physics II (3.0 cr)

PHYS 8750 - Advanced Topics in Condensed Matter Physics (3.0 cr) PHYS 8700 - Seminar: Condensed Matter Physics (1.0 cr) •Elementary Particle Physics •PHYS 4511 - Introduction to Nuclear and Particle Physics (3.0 cr) PHYS 8011 - Quantum Field Theory I (3.0 cr) PHYS 8012 - Quantum Field Theory II (3.0 cr) PHYS 8013 - Special Topics in Quantum Field Theory (3.0 cr) PHYS 8901 - Elementary Particle Physics I (3.0 cr) PHYS 8902 - Elementary Particle Physics II (3.0 cr) PHYS 8911 - Introduction to Supersymmetry (3.0 cr) PHYS 8950 - Advanced Topics in Elementary Particle Physics (3.0 cr) PHYS 8900 - Seminar: Elementary Particle Physics (1.0 cr) •Mathematical, Advanced Quantum, and Computational Physics •PHYS 5041 - Mathematical Methods for Physics (4.0 cr) PHYS 8001 - Advanced Quantum Mechanics (3.0 cr) PHYS 8301 - Symmetry and Its Application to Physical Problems (3.0 cr) •Nuclear Physics •PHYS 8801 - Nuclear Physics I (3.0 cr) PHYS 8802 - Nuclear Physics II (3.0 cr) PHYS 8850 - Advanced Topics in Nuclear Physics (3.0 cr) PHYS 8800 - Seminar: Nuclear Physics (1.0 cr) •Plasma and Space Physics •PHYS 4611 - Introduction to Space Physics (3.0 cr) PHYS 4621 - Introduction to Plasma Physics (3.0 cr) PHYS 8601 - Plasma Physics I (3.0 cr) PHYS 8602 - Plasma Physics II (3.0 cr) PHYS 8611 - Cosmic Rays and Plasma Astrophysics (3.0 cr) PHYS 8650 - Advanced Topics in Space and Plasma Physics (3.0 cr) PHYS 8600 - Seminar: Space Physics (1.0 cr) •Relativity and Cosmology •PHYS 5022 - Relativity, Cosmology, and the Universe (4.0 cr) PHYS 8501 - General Relativity and Cosmology I (3.0 cr) PHYS 8502 - General Relativity and Cosmology II (3.0 cr) PHYS 8200 - Seminar: Cosmology and High Energy Astrophysics (1.0 cr)

Physics Education

PHYS 5072 - Best Practices in College Physics Teaching (1.0 - 3.0 cr)

PHYS 8100 - Seminar: Problems of Physics Teaching and Higher Education (1.0 cr)

### **Thesis Credits**

Take 24 credits (maximum 14 credits per term) after passing preliminary oral exam. PHYS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)