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## PHYSICS (Ph.D.)

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*For the most up-to-date faculty listings and specializations, see the program's Web site.*

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## THE PROGRAM

The Ph.D. Program in Physics prepares students to enter into the mainstream of contemporary physics by providing them with an opportunity to pursue original research. Students in the program receive a sound background in the fundamentals of physics through intensive course work in core subjects as well as an opportunity to develop individual interests through a selection of modern electives. Most graduate courses are given at the Graduate Center. Generally, thesis work is done on the participating campuses.

The graduate student may choose a research specialization from the principal areas of modern theoretical and experimental physics. The research programs are particularly strong in the following areas: elementary particle and high-energy physics; solid state and condensed matter physics; laser physics and quantum optics; atomic and molecular physics; astrophysics; geophysics and fluid dynamics (including earth and planetary physics); biophysics; biomedical physics; low-energy nuclear physics; relativity; organic insulator radiation damage; thin film superconductor physics; and theoretical plasma physics. These research programs are carried out at one or more of the campuses participating in the Ph.D. Program in Physics, where students have access to excellent modern facilities, shops, libraries, and various departmental and university computers. Some research opportunities are also available at other senior colleges of CUNY. Brooklyn College participates in the use of the light source at Brookhaven National Laboratories. The City College also participates in cooperative programs in experimental high-energy physics with the major facility at Brookhaven National Laboratory, and in astrophysics with the NASA Goddard Space Center, which is ten minutes away from the college.

The program encompasses many of the most active areas of research in present-day physics. In addition to research in well-defined and traditional areas such as high-energy and particle physics, solid state and condensed matter, laser physics, atomic and molecular physics, nuclear physics, plasma physics, and others, the program is very sensitive to the changes now occurring in physics, such as the resurgent interest in high-temperature superconductivity and superstring theory. Several interdisciplinary areas such as biophysics, biomedical physics, computational physics, and fluid-geophysics have been developed, and others are planned as the need arises. Students interested in research in any of these areas will be helped by the faculty to design a suitable program.

In addition to the program's large doctoral faculty, including many with national and international reputations, numerous visiting professors and postdoctoral research associates from all over the world join the various departments temporarily and add to the lively spirit of research. A high ratio of faculty to students makes for a great deal of intimate contact and small class size. Close association with the faculty permits students maximum benefit in choosing a program and in pursuing their graduate studies.

Stipends of approximately \$21,000 a year that permit students a modest but decent living standard in New York City are available at the colleges. Financial assistance is also available to doctoral students through fellowships and assistantships awarded by the Graduate Center. In practice, most graduate students in Physics are supported during their entire course of study.

***En-route M.A.***

Upon completing 45 credits with an average grade of B, passing the First Examination, and satisfactorily completing a major research paper, the student may apply for an M.A. degree. The degree is awarded formally by one of the participating CUNY colleges.

**SPECIAL REQUIREMENTS FOR ADMISSION**

In addition to the general University requirements for admission stated earlier in this bulletin, applicants must have received a minimum average of B in their work in undergraduate physics and mathematics and have taken a sufficient number of courses in these fields to indicate that they will profit from graduate study in physics. Applicants with master's degrees in physics from accredited institutions may be considered for admission, even if they do not satisfy the above requirements.

**SPECIAL REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY**

The general University requirements are stated earlier in this bulletin. The special requirements in Physics are as follows.

*Course of Study* The student's course of study must have the approval of an adviser. Of the 60 credits of graduate work required for the degree, no more than 9 credits may be in first-level courses; with special permission, up to 18 credits may be taken in subjects other than physics. After students pass the First Examination, they are encouraged to choose a thesis field and adviser; these decisions should normally be made within a year of passing the First Examination. Doctoral students at all the colleges are expected to attend the weekly colloquia.

*First Examination* The student must pass the First Examination, which includes quantum mechanics, analytic dynamics, electromagnetic theory, and general physics (which covers topics selected from the fields of atomic and nuclear physics, solid state, thermodynamics, and statistical mechanics and optics). For students specializing in fluid-geophysics, an examination in that area may be substituted for the quantum mechanics part of the First Examination.

*Second Examination* The Second Examination tests the student's knowledge of the general areas of physics bearing on his or her field of research as well as the student's readiness to undertake a specific piece of research. Detailed information concerning the examination is available from the Executive Officer.

*Dissertation* The student is required to prepare the dissertation under the guidance of an adviser. Upon completion, the dissertation will be submitted to the guidance committee appointed for the student. The degree is recommended upon approval of the dissertation by the committee and upon successful completion of an oral defense of the dissertation before the committee. The dissertation must be of such a caliber as to be acceptable for publication in a standard journal when suitably condensed.

*College Teaching* Each student is required to participate in some teaching of undergraduate physics courses. Specific requirements are determined for each student in consultation with the Executive Officer and the appropriate department chair. In special cases research may be substituted for this requirement.

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## Courses

60000-level courses are given at one or several of the colleges. Their numbers and titles are as follows:

- PHYS 60100 Introduction to Mathematical Physics
- PHYS 61100 Analytical Mechanics
- PHYS 61500 Electromagnetic Theory
- PHYS 62100 Electronics
- PHYS 62500 Introduction to Quantum Mechanics
- PHYS 62600 Atomic Physics and Quantum Mechanics
- PHYS 63500-63600 Introduction to Modern Physics I, II
- PHYS 64100 Statistical Physics
- PHYS 64500 Solid State Physics
- PHYS 65700 Introduction to Astrophysics
- PHYS 67100-67200 Modern Physics Laboratory

For descriptions and other particulars concerning these courses, consult the appropriate college graduate catalog.

The following 70000-level and 80000-level courses are given at one or several of the participating colleges—Brooklyn, City, Hunter, and Queens.

Unless otherwise stated, all courses are *45 hours plus conferences, 4 credits*.

PHYS 70100-70200 Mathematical Methods in Physics  
*Each 60 hours or 45 hours plus conferences, 4 credits*

PHYS 71100 Analytical Dynamics  
*60 hours or 45 hours plus conferences, 4 credits*  
*Prerequisite: PHYS 60100 or corequisite 70100*

PHYS 71500-71600 Electromagnetic Theory  
*Each 60 hours or 45 hours plus conferences, 4 credits*  
*Prerequisite: PHYS 60100 or corequisite PHYS 70100*

PHYS 72500-72600 Quantum Mechanics  
*Each 60 hours or 45 hours plus conferences, 4 credits*  
*Prerequisite: PHYS 60100 or PHYS 70100*

PHYS 73000\* Atomic Physics  
*Prerequisites: PHYS 71600 and 72500*

PHYS 73200 Optics  
*Prerequisites: An undergraduate course in optics and PHYS 71500*

PHYS 73400 Introduction to Relativity  
*Prerequisite: PHYS 71100*

PHYS 73500\* Nuclear Physics  
*Prerequisite: PHYS 72500*

PHYS 73600\* Particle Physics  
*Prerequisite: PHYS 73500*

- PHYS 73800 Biophysics  
*45 hours plus conferences, 4 credits*
- PHYS 74100 Statistical Mechanics  
*Prerequisite: PHYS 72500*
- PHYS 74300-74400\* Geophysical Hydrodynamics  
*Each 45 hours, 3 credits*  
*Pre- or corequisites: PHYS 60100 or 70100*
- PHYS 74500 Solid State Physics  
*Prerequisite: PHYS 72500*
- PHYS 74800-74900 Theory of Relativity and Gravitation  
*Prerequisites: PHYS 71100 and 71600*
- PHYS 75000-75100\* Plasma Physics  
*Prerequisites: PHYS 64100 or 74100; 71100, 71500, 71600*
- PHYS 75700 Astrophysics  
*Prerequisite: PHYS 63600*
- PHYS 75800\* Galactic Physics I (Theoretical Aspects)  
*Prerequisites: PHYS 64100, 71100, and 71500*
- PHYS 75900\* Galactic Physics II (Observational Aspects)  
*Prerequisites: PHYS 64100, 71100, and 71500*
- PHYS 76000\* Cosmology  
*Prerequisites: PHYS 64100, 71100, and 71500*
- PHYS 77100-77300 Graduate Physics Laboratory  
*Each 45 hours, 2 credits*
- PHYS 81200\* Continuum Mechanics  
*Prerequisites: PHYS 71100 and 71500*
- PHYS 82500-82600 Quantum Theory of Fields  
*Prerequisite: PHYS 72600*
- PHYS 83500-83600 Theoretical Nuclear Physics  
*Prerequisite: PHYS 73500*
- PHYS 84500-84600 Quantum Theory of Solids  
*Prerequisites: PHYS 72600 and 64500 or 74500*
- PHYS 84700\* Stellar Physics  
*Prerequisites: PHYS 75700 or 65700; 64100; and 72500*
- PHYS 84800\* Stellar Evolution  
*Prerequisites: PHYS 84700 or 65700*
- PHYS 84900\* Advanced Theory of Gravitation  
*Prerequisite: PHYS 72600 and 74900*
- PHYS 85100-85900 Selected Topics in Advanced Physics  
*Each up to 45 hours plus conference, up to 4 credits*
- PHYS 89900 Independent Research  
*1-4 credits*
- PHYS 90000 Dissertation Supervision  
*1 credit*
- \*offered infrequently