PHYSICS & ASTRONOMY

504A Altschul Hall
212-854-3628
Department Administrative Assistant: Joanna Chisolm

Mission

The mission of the Physics and Astronomy Department at Barnard College is to provide students with an understanding of the basic laws of nature, and a foundation in the fundamental concepts of classical and quantum physics, and modern astronomy and astrophysics. Majors are offered in physics, astronomy, or in interdisciplinary fields such as, astrophysics, biophysics, or chemical physics. The goal of the department is to provide students (majors and non-majors) with quality instruction and prepare them for various post-graduate career options, including graduate study in physics and/or astronomy, professional careers in science, technology, education, or applied fields, as well health-related professions. The department strives to be a source of distinguished women scientists. The faculty in the department maintain NSF or NASA-sponsored active research programs that involve undergraduate students. All majors engage in at least one summer of independent research that is often continued during the semester, or the following summer. Students may also carry out their research at other institutions nationally, through NSF-REU (Research Experience for Undergraduates) programs. Students are required to present the results of their research in the annual departmental “Senior Talks,” held in May.

Student Learning Goals

- Acquire a strong intellectual foundation in physics and/or astronomy.
- Apply scientific thinking to problems in physics and/or astronomy, and translate this to real life problems.
- Use mathematics to describe and manipulate abstract concepts in physics and/or astronomy.
- Perform laboratory experiments to study various physical phenomena, and use statistical approaches to analyze and interpret the data obtained in these experiments.
- Acquire effective oral and written presentation skills to communicate scientific ideas.
- Participate in a research project and stimulate the ability of empirical thought.
- Demonstrate the ability to give a scientific talk on a research topic.

Student Learning Outcomes

Upon successfully completing the major, students should have the ability to:

- demonstrate a conceptual understanding of the physical laws of nature.
- demonstrate a thorough knowledge of the various subject areas of physics (e.g. classical mechanics, quantum physics, electromagnetism, and thermodynamics) and/or astronomy (e.g. stellar structure and evolution, physics of the solar system, physical cosmology, and observational astronomy).
- apply problem-solving skills beyond graduation in advanced physics and/or astronomy courses in graduate school and independent research projects.
- apply problem-solving and computation skills in future situations in applied or technical jobs, or careers in finance and industry.
- make an effective oral presentation to an audience of peers and faculty on a particular research topic.

From Aristotle's Physics to Newton's Principia, the term "physics," taken literally from the Greek φυσις (= Nature), implied natural science in its very broadest sense. Physicists were, in essence, natural philosophers, seeking knowledge of the observable phenomenal world. Astronomy originally concentrated on the study of natural phenomena in the heavens with the intent to understand the constitution, relative positions, and motions of the celestial bodies in our universe. Though practitioners of these disciplines have become somewhat more specialized in the past century, the spirit that guides them in their research remains the same as it was more than two millennia ago.

In cooperation with the faculty of the University, Barnard offers a thorough pre-professional curriculum in both physics and astronomy. The faculty represents a wide range of expertise, with special strength and distinction in theoretical physics, condensed matter physics, and observational astrophysics.

Separate majors in physics and astronomy are offered. A major in astrophysics is also possible. Furthermore, there are many special interdisciplinary majors possible, such as biophysics, chemical physics, engineering physics, and mathematical physics. There is a physics minor as well. Students should consult members of the department early on in their undergraduate careers in order to plan the most effective course of study. Qualified seniors are invited to participate in the seniors honors program, in which they carry out a year-long research project leading to the thesis.

There are several quite distinct introductory sequences in physics, only one of which may be taken for credit:

1. PHYS UN1001 Physics for Poets - PHYS UN1001 Physics for Poets is a lecture course in physics intended for liberal arts students. A semester of this CU lecture course satisfies the BC Quantitative Reasoning requirement. Note, however, that 1001-2 does not satisfy the premedical nor physics requirement for any major. It should also not be taken to satisfy the BC lab science requirement.
2. PHYS UN1201 General Physics I - PHYS UN1202 General Physics II is satisfactory preparation for medical school and is appropriate for most non-science major premedical students. This course is taught at Columbia in a large lecture hall setting. It is not recommended as a foundation for more advanced work in the field. Taken in conjunction with PHYS UN1291 General Physics Laboratory - PHYS UN1292 General Physics Laboratory II, this sequence does satisfy the college LAB requirement, but the student population is essentially premed. Note that PHYS UN1201 General Physics I / PHYS UN1202 General Physics II are required in order to take the lab course.
3. PHYS BC2001 Physics I: Mechanics - PHYS BC2002 Physics II: Electricity and Magnetism, PHYS BC3001 Physics III: Classical Waves & Optics is Barnard's own three-semester, calculus based introductory sequence in physics. Characterized by modest class sizes, it is designed specifically for Barnard women with a serious interest in any of the natural sciences or mathematics. Moreover, it is especially appropriate for majors in physics, chemistry, or biochemistry, whether premedical or not. Biology majors with some calculus background are also encouraged to take this sequence. Finally, Barnard women contemplating a major in physics or astronomy should take PHYS BC2001 Physics I: Mechanics - PHYS BC2002 Physics II: Electricity and Magnetism in their first year, if possible, or in their second at the latest, to be followed by the third-semester course, Classical Waves and Optics.

4. First-year students with exceptional aptitude for physics (as evidenced, for example, by scores of 4 or 5 on the advanced placement C exam) and a good mathematical background may be admitted into the Columbia-taught two-semester sequence PHYS UN2801 Accelerated Physics I - PHYS UN2802 Accelerated Physics II, which replaces all three terms of the sequence for majors. Students considering this sequence are strongly encouraged to consult a Barnard faculty member at the start of the term.

Students unsure about the most appropriate sequence should consult members of the department.

The following courses may be substituted for each other:

PHYS BC2001 Physics I: Mechanics-PHYS BC2002 Physics II: Electricity and Magnetism (sect.1; 4.5pts) = PHYS UN1601 Physics, I: Mechanics and Relativity - PHYS UN1602 Physics, II: Thermodynamics, Electricity, and Magnetism (3.0pts.) + PHYS BC2001 Physics I: Mechanics - PHYS BC2002 Physics II: Electricity and Magnetism (sect.3; 1.5pts.)
PHYS BC3001 Physics III: Classical Waves & Optics (sect.1; 5pts) = PHYS UN2601 Physics, III: Classical and Quantum Waves (3.0pts) + PHYS BC3001 Physics III: Classical Waves & Optics(sect.3; 2pts)
ASTR BC1753 LIFE IN THE UNIVERSE - ASTR BC1754 Stars, Galaxies, and Cosmology = ASTR UN1403 Earth, Moon and Planets (Lecture) - ASTR C1404 Stars, Galaxies, and Cosmology

Chair: Laura Kay
Professors: Timothy Halpin-Healy (Ann Whitney Olin Professor), Reshmi Mukherjee (Helen Goodhart Altschul Professor)
Associate Professor: Janna Levin
Lab Director: Stiliana Savin

Other officers of the University offering courses listed below:

Professors: James Applegate, Norman Christ, Brian Cole, Arlin Crotts, Charles Hailey, Jules Halpern, Tony Heinz, David Helfand, Robert Mawhinney, John Parsons, Frederik Paerels, Joseph Patterson, Michael Shaevitz, Michael Tuts, Jacqueline van Gorkom, William Zajc
Associate Professors: Greg Bryan, Zoltan Haiman, Kathryn Johnson, Kristen Menou, David Schiminovich
Adjunct Professors: Burton Budick, Morgan May

Requirements for the Astronomy Major

The courses required for the major in astronomy are as follows:

PHYS BC2001	Physics I: Mechanics *	4.5
PHYS BC2002	Physics II: Electricity and Magnetism *	4.5
PHYS BC3001	Physics III: Classical Waves & Optics *	5
Calculus through IV is required, with additional work in mathematics recommended		
ASTR UN2001 - ASTR UN2002	Introduction To Astrophysics, I and INTRO TO ASTROPHYSICS II	6
Students are required to take four additional 3000-level ASTR or PHYS courses, including at least one of ASTR UN3102 or PHYS UN3003, and selected so that at least six total points of 3000-level lecture classes are ASTR courses		
Some of the ASTR courses offered in recent year include:		
ASTR UN3101	Modern Stellar Astrophysics II	3
ASTR UN3103	GALAXIES	3
ASTR UN3105	Extrasolar Planets and Astrobiology	3
ASTR UN3602	Physical Cosmology and Extragalactic Astronomy	3
ASTR UN3273	High Energy Astrophysics	3
ASTR UN3646	Observational Astronomy	3
ASTR C3601	General Relativity, Black Holes, and Cosmology	3

* Students may substitute a Columbia College three-semester calculus-based introductory physics sequence with lab taken at Barnard, as in the physics major.

** Students who have taken ASTR BC1753 LIFE IN THE UNIVERSE-ASTR BC1754 Stars, Galaxies, and Cosmology or ASTR UN1403 Earth, Moon and Planets (Lecture)-ASTR UN1404 STARS, GALAXIES # COSMOLOGY may substitute an additional 3000-level ASTR course for ASTR UN2001 Introduction To Astrophysics, I-ASTR UN2002 INTRO TO ASTROPHYSICS II.

Students planning to study astronomy or astrophysics in graduate school are strongly urged to take PHYS BC3006 Quantum Physics, PHYS UN3003 Mechanics, PHYS UN3007 Electricity and Magnetism-PHYS UN3008 Electromagnetic Waves and Optics, PHYS GU4023 Thermal and Statistical Physics, some additional courses in mathematics, and Computer Science COMS W1001 Introduction to Information Science or COMS W1004 Introduction to Computer Science and Programming in Java. Note: When any of the required courses is not being given, the department will recommend appropriate substitutions.

Requirements for the Physics Major

The courses required for the major in physics are:

PHYS BC2001	Physics I: Mechanics *	4.5
PHYS BC2002	Physics II: Electricity and Magnetism *	4.5
PHYS BC3001	Physics III: Classical Waves & Optics *	5
Calculus through IV is required, with additional work in mathematics recommended; e.g., MATH E1201-2, APMA E3102. The calculus sequence should be completed by the end of the sophomore year.		
PHYS UN3003	Mechanics	3
PHYS BC3006	Quantum Physics	3
PHYS UN3007	Electricity and Magnetism	3
PHYS UN3008	Electromagnetic Waves and Optics	3
PHYS GU4023	Thermal and Statistical Physics	3
PHYS BC3086 - PHYS BC3088	Quantum Physics Laboratory and Advanced Electromagnetism Laboratory (taken concurrently with their cognate lecture courses)	6
Select one of the following:		3
COMS W1001	Introduction to Information Science	3
COMS W1004	Introduction to Computer Science and Programming in Java	3
PHYS UN3083	Electronics Laboratory	3

* In lieu of the introductory courses PHYS BC2001 Physics I: Mechanics,PHYS BC2002 Physics II: Electricity and Magnetism, PHYS BC3001 Physics III: Classical Waves & Opticsany three-semester Columbia introductory sequence acceptable for the physics major in Columbia College will do (e.g., PHYS UN1601 Physics, I: Mechanics and Relativity-PHYS UN1602 Physics, II: Thermodynamics, Electricity, and Magnetism, PHYS UN2601 Physics, III: Classical and Quantum Waves. The accelerated two-semester Columbia College sequence PHYS UN2801 Accelerated Physics I-PHYS UN2802 Accelerated Physics II is also acceptable. In that case, the major has a 10 course minimum. We strongly encourage students interested in the Columbia sequences to seek advice from the Chair of the Barnard Physics & Astronomy Department.
  Note that Calculus I-III (MATH UN1101 CALCULUS I,MATH UN1102 CALCULUS II,MATH UN1201 Calculus III)are co-requisites or pre-requisites for many of these classes. MATH UN1202 CALCULUS IV is required as a cognate course, with additional work in mathematics recommended: e.g. Ordinary Differential Equations, APMA E3102 Partial Differential Equations. The calculus sequence should be completed by the end of the sophomore year.

Students planning to study physics in graduate school should include several 4000-level electives in their senior year program.

Interdisciplinary Major

Special majors in, for example, astrophysics, biophysics, chemical physics, engineering physics, or mathematical physics are all possible and are arranged in conjunction with the relevant second department at Barnard. A student interested in such possibilities should speak to a faculty member early on (i.e., by late fall of her sophomore year) in order to permit the most effective construction of her program of study and the appropriate petition to be made to the Committee on Programs and Academic Standing. The latter is a straightforward procedure associated with the declaration of all special majors at Barnard.

Requirements for the Physics Minor

Five courses are required for the minor in physics. They are: any three-semester introductory sequence acceptable for the major (see above) plus two additional 3-point courses at the 3000-level.

Requirements for the Astronomy Minor

2 semesters of Physics with Lab (7-9 pts)

*Students who are majoring in science can omit one semester of 1-1.5 pts of Physics Lab.

4 courses in astronomy or astrophysics at the 2000 level or above. (12 pts)

*One of these courses can be replaced by two 1000-level Astronomy courses.

*An additional 3 pts of physics at the 3000 level or above can substitute for 3 points of astronomy.

Astronomy Courses

ASTR BC1753 LIFE IN THE UNIVERSE. *3.00 points*.
An introductory course intended primarily for nonscience majors. This interdisciplinary course focuses on the subject of LIfe in the Universe. We will study historical astronomy, gravitation and planetary orbits, the origin of the chemical elements, the discoveries of extrasolar planets, the origin of life on Earth, the evolution and exploration of the Solar Systen, global climate change on Venus, Mars and Earth, and the Search for Extraterrestrial Life (SETI). You cannot receive credit for this course and for ASTR UN1403 or ASTR UN1453. Can be paired with the optional Lab class ASTR UN1903

ASTR BC1754 Stars, Galaxies, and Cosmology. *3 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA).

Prerequisites: Recommended preparation: A working knowledge of high school algebra.
Corequisites: Suggested parallel laboratory course: ASTR C 1904y.
Examines the properties of stars, star formation, stellar evolution and nucleosynthesis, the Milky Way and other galaxies, and the cosmological origin and evolution of the universe. Students may not receive credit for both ASTR BC 1754 and ASTR C1404.

Spring 2021: ASTR BC1754

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1754	001/00484	M W 10:10am - 11:25am 903 Altschul Hall	David Helfand	3	55

ASTR UN1234 The Universal Timekeeper: Reconstructing History Atom by Atom. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: high school algebra and latent curiosity are assumed.
The goal of the course is to illustrate — and perhaps even inculcate — quantitative and scientific reasoning skills. The subject material employed in this task is the study of atoms and their nuclei which, through a wide variety of physical and chemical techniques, can be used to reconstruct quantitatively the past. Following an introduction to atoms, light, and energy, we will explore topics including the detection of art forgeries, the precise dating of archeological sites, a reconstruction of the development of agriculture and the history of the human diet, the history of past climate (and its implications for the future), the history and age of the Earth, and the history of the Universe. The course has no required text. Readings of relevant articles and use of on-line simulations will be required.

ASTR UN1403 Earth, Moon and Planets (Lecture). *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: recommended preparation: a working knowledge of high school algebra.
The overall architecture of the solar system. Motions of the celestial sphere. Time and the calendar. Major planets, the earth-moon system, minor planets, comets. Life in the solar system and beyond. This course is similar to ASTR BC 1753. You cannot enroll in both courses and receive credit for both.

Spring 2021: ASTR UN1403

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1403	001/11739	T Th 1:10pm - 2:25pm Online Only	James Applegate	3	68/75

Fall 2021: ASTR UN1403

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1403	001/12831	T Th 10:10am - 11:25am 413 Kent Hall	David Helfand	3	44/75

ASTR UN1404 STARS, GALAXIES # COSMOLOGY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Distances to, and fundamental properties of, nearby stars; nucleosynthesis and stellar evolution; novae and supernovae; galaxies; the structure of the universe and theories concerning its origin, evolution, and ultimate fate. You can only receive credit for ASTR UN1404 if you have not taken ASTR BC1754, ASTR UN1420 or ASTR UN1836

Fall 2021: ASTR UN1404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1404	001/12832	T Th 1:10pm - 2:25pm 702 Hamilton Hall	James Applegate	3.00	53/75

ASTR UN1420 Galaxies and Cosmology. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Galaxies contain stars, gas dust, and (usually) super-massive black holes. They are found throughout the Universe, traveling through space and occasionally crashing into each other. This course will look at how these magnificent systems form and evolve, and what they can tell us about the formation and evolution of the Universe itself. You cannot enroll in ASTR UN1420 in addition to ASTR BC1754 or ASTR UN1404 and receive credit for both.

ASTR UN1453 Another Earth. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement
This course cannot be taken for credit if BC1753 has been taken.

This course will explore the unique properties of Earth, compared to other planets in the Solar System, and the possibility of Earth-like planets around other stars. The basics of the Solar System, gravity, and light will be covered, as well as the geology and atmospheres of the terrestrial planets. The properties of Earth that allowed life to develop and whether life can develop on other planets will be discussed. Finally, the discovery of planets beyond our Solar System and the likelihood of another Earth will be a key component of the course.

Spring 2021: ASTR UN1453

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1453	001/11740	M W 2:40pm - 3:55pm Online Only	Mary Putman	3	68/75

Fall 2021: ASTR UN1453

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1453	001/12833	T Th 1:10pm - 2:25pm Cin Alfred Lerner Hall	Caleb Scharf	3	75/75

ASTR UN1610 THEOR-UNIVERS:BABYLON-BIG BANG. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Milestones in the science of cosmology over the past 6000 years. Skylore and observation in ancient cultures. The twin revolutions of the Greeks: Pythagoras and Ptolemy; and Aristotle, Aquinas, and the Great Chain of Being. The scientific revolution: the impersonal and deterministic world-order of Newton, Laplace, and Kelvin. The erosion of that world-order by mathematics and experiment in the 20th century (relativity, quantum physics, dark matter, and the expanding universe). Todays searches for a new grand order in the Universe, which can cope - or maybe not - with these blows to yesterdays comfortable wisdom

ASTR UN1836 Stars and Atoms. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: recommended preparation: a working knowledge of high school algebra.
What is the origin of the chemical elements? This course addresses this question, starting from understanding atoms, and then going on to look at how how atoms make stars and how stars make atoms. The grand finale is a history of the evolution of the chemical elements throughout time, starting from the Big Bang and ending with YOU. You cannot enroll in ASTR UN1836 in addition to ASTR BC1754 or ASTR UN1404 and receive credit for both.

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What is the origin of the chemical elements? This course addresses this question, starting from understanding atoms, and then going on to look at how how atoms make stars and how stars make atoms. The grand finale is a history of the evolution of the chemical elements throughout time, starting from the Big Bang and ending with YOU. You cannot enroll in ASTR W1836 in addition to ASTR BC1754 or ASTR W1404 and receive credit for both.

Spring 2021: ASTR UN1836

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1836	001/11741	M W 1:10pm - 2:25pm Online Only	Marcel Agueros	3	34/40

Fall 2021: ASTR UN1836

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1836	001/12834	M W 1:10pm - 2:25pm 313 Fayerweather	Kathryn Johnston	3	42/75

ASTR UN1903 ASTRONOMY LAB I. *1.00 point*.
Laboratory for ASTR UN1403. Projects include observations with the departments telescopes, computer simulation, laboratory experiments in spectroscopy, and the analysis of astronomical data. Lab 1 ASTR UN1903 - goes with ASTR BC1753, ASTR UN1403 or ASTR UN1453

Spring 2021: ASTR UN1903

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1903	001/12738	T 6:00pm - 9:00pm Online Only	David Schiminovich, Yuxi Lu	1.00	9/12
ASTR 1903	002/12739	M 6:00pm - 9:00pm Online Only	David Schiminovich, Christopher Carr	1.00	7/12

Fall 2021: ASTR UN1903

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1903	001/00150	M 6:00pm - 9:00pm Room TBA	Laura Kay, Alina Sabyr	1.00	10/12
ASTR 1903	002/00151	T 6:00pm - 9:00pm Room TBA	Laura Kay, Chengcheng Xin	1.00	8/12

ASTR UN1904 ASTRONOMY LAB II. *1.00 point*.
Laboratory for ASTR UN1404. Projects include use of telescopes, laboratory experiments in the nature of light, spectroscopy, and the analysis of astronomical data. Lab 2 ASTR UN1904 - goes with ASTR BC1754 or ASTR UN1404 (or ASTR UN1836 or ASTR UN1420)

Spring 2021: ASTR UN1904

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1904	001/12740	W 7:00pm - 10:00pm Online Only	David Schiminovich, Karen Perez	1.00	12/14

Fall 2021: ASTR UN1904

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 1904	001/00146	W 7:00pm - 10:00pm Room TBA	Laura Kay, Jingyao Zhu, Jennifer Mead	1.00	11/12

ASTR UN2001 Introduction To Astrophysics, I. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: a working knowledge of calculus.
Corequisites: a course in calculus-based general physics.
First term of a two-term calculus-based introduction to astronomy and astrophysics. Topics include the physics of stellar interiors, stellar atmospheres and spectral classifications, stellar energy generation and nucleosynthesis, supernovae, neutron stars, white dwarfs, and interacting binary stars.

Fall 2021: ASTR UN2001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 2001	001/12835	M W 1:10pm - 2:25pm 304 Hamilton Hall	Marcel Agueros	3	39/35

ASTR UN2002 INTRO TO ASTROPHYSICS II. *3.00 points*.
Prerequisites: a working knowledge of calculus.
Corequisites: the second term of a course in calculus-based general physics.
Prerequisites: a working knowledge of calculus. Corequisites: the second term of a course in calculus-based general physics. Continuation of ASTR UN2001; these two courses constitute a full year of calculus-based introduction to astrophysics. Topics include the structure of our galaxy, the interstellar medium, star clusters, properties of external galaxies, clusters of galaxies, active galactic nuclei, and cosmology

Spring 2021: ASTR UN2002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 2002	001/11742	M W 8:40am - 9:55am Online Only	Frederik Paerels	3.00	30/45

ASTR UN2900 Frontiers of Astrophysics. *1 point*.
Several members of the faculty each offer a brief series of talks providing context for a current research topic in the field and then present results of their ongoing research. Opportunities for future student research collaboration are offered. Grading is Pass/Fail.

Fall 2021: ASTR UN2900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 2900	001/12836	F 10:10am - 11:25am 614 Schermerhorn Hall	Caleb Scharf	1	56/50

ASTR UN3101 Modern Stellar Astrophysics II. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one year of calculus-based general physics.
Introductory astronomy is not required, but some exposure to astronomy is preferable. In the first half of the course, we will examine the physics of stellar interiors in detail, leading us to develop models of stellar structure and consider how stars evolve. In the second half of the course, we will discuss special topics, such as pre-main sequence evolution, the late stages of stellar evolution, and supernovae and compact objects.

ASTR UN3102 Planetary Dynamics and Physics of the Solar System. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one year of calculus-based Physics.
The physics and astrophysics of planets, comets, asteroids, natural and artificial satellites, and pretty much anything in the Solar System - including the Sun. Detailed study of the Earth's atmosphere and oceans: circulations, climate, and weather. Orbital dynamics. The emerging science of extrasolar planets. The origin, evolution, and eventual fate of planets.

ASTR UN3103 GALAXIES. *3.00 points*.
Prerequisites: one year of calculus-based general physics.
Prerequisites: one year of calculus-based general physics. Galaxies fill the universe with structure. They are bound objects that harbor stars, gas, dust and dark matter. This course will discuss the content and structure of galaxies. It will start with the Milky Way, a rotating spiral galaxy, with a particular emphasis on the properties of the interstellar medium. Dwarf galaxies, the building blocks of larger galaxies, will subsequently be discussed, followed by spiral, elliptical and irregular galaxies. The formation and evolution of these different galaxy types will be an important focus of the course, as well as the environment in which the galaxies reside. We will intersperse reviews of current papers on galaxies throughout the semester

Spring 2021: ASTR UN3103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 3103	001/11743	T Th 1:10pm - 2:25pm 307 Pupin Laboratories	David Schiminovich	3.00	21/25

ASTR UN3105 Extrasolar Planets and Astrobiology. *3 points*.
Prerequisites: One year of calculus-based physics.
The emerging field of extrasolar planets and astrobiology will be covered at a quantitative level, with a major emphasis on astrophysical phenomenae and techniques. The subject will be introduced through an investigation of current planetary formation theories and approaches to planet detection, including what we currently know about extrasolar planets and detailed reference to state-of-the-art studies. An astronomer's view of the origin of life and extreme biology will be developed and applied to questions of cosmo-chemistry, observable life-signatures, habitable zones and other astrophysical constraints on the development of organisms.

Fall 2021: ASTR UN3105

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 3105	001/12837	T Th 10:10am - 11:25am 1332 Pupin Laboratories	David Kipping	3	16/20

ASTR UN3106 The Science of Space Exploration. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one semester course in introductory astronomy or astrophysics (e.g., ASTR UN1403, ASTR UN1404, ASTR UN1420, ASTR UN1836, ASTR UN2001, ASTR UN2002, ASTR BC1753, ASTR BC1754). Ability in mathematics up to and including calculus is strongly urged.
How and why do humans explore space? Why does it require such extraordinary effort? What have we found by exploring our Solar System? We investigate the physics and biological basis of space exploration, and the technologies and science issues that determine what we can accomplish. What has been accomplished in the past, what is being explored now, and what can we expect in the future? How do space scientists explore the Solar System and answer science questions in practice? What do we know about solar systems beyond our own?

ASTR UN3273 High Energy Astrophysics. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one year of calculus-based general physics. No previous, \nastronomy background required.
A survey of the most energetic and explosive objects in the Universe and their radiation. Topics include: techniques of X-ray and gamma-ray astronomy; observations of neutron stars (pulsars) and black holes; accretion disks and relativistic jets; supernovae, supernova remnants, gamma-ray bursts, quasars and active galactic nuclei; clusters of galaxies; cosmic rays and neutrinos.

ASTR UN3602 Physical Cosmology and Extragalactic Astronomy. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one year of calculus-based general physics.
The standard hot big bang cosmological model and modern observational results that test it. Topics include the Friedmann equations and the expansion of the universe, dark matter, dark energy, inflation, primordial nucleosynthesis, the cosmic microwave background, the formation of large-scale cosmic structures, and modern cosmological observations.

Fall 2021: ASTR UN3602

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ASTR 3602	001/12838	M W 10:10am - 11:25am 415 Schapiro Cepser	Zoltan Haiman	3	19/25

ASTR UN3646 Observational Astronomy. *3 points*.
Prerequisites: one year of general astronomy
Introduction to the basic techniques used in obtaining and analyzing astronomical data. Focus on 'ground-based' methods at optical, infrared, and radio wavelengths. Regular use of the telescope facilities atop the roof of the Pupin Labs. In research projects, students also work on the analysis of data obtained at National Observatories.

ASTR UN3985 Statistics and the Universe (Seminar). *3 points*.
Prerequisites: First year calculus required, introductory physics or astronomy
Essential statistical methods will be applied in a series of case studies and research projects taken from the latest advances in cosmology, astronomy and physics. Statistics of measurement and detection, fundamentals of hypothesis testing, classifications, data modeling, time-series analysis, correlation and clustering will be explored through hands-on investigation using data from recent experiments and surveys.

ASTR UN3996 Current Research in Astrophysics. *1 point*.
Prerequisites: two semesters of astronomy classes and two semesters of physics classes.
The goal of this course is to introduce astronomy and astrophysics majors to the methods and topics of current astronomical research. The course will also help with the development of critical thinking skills. Each week, the topic of the course will be centered on the subject of the Astronomy department colloquium; this may include research on planets, stars, galaxies or cosmology. There will be two required meetings per week: the first will be to discuss papers related to the colloquium (time TBD), and the second will be the colloquium itself (at 4:15 pm each Wednesday). Grading is Pass/Fail.

ASTR GU4302 General Relativity, Black Holes, and Cosmology. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one year of calculus-based general physics.
Einstein's General Theory of Relativity replaced Newtonian gravity with an elegant theory of curved spacetime. Einstein's theory led to unforseen and unnerving predictions of singularities and cosmological instabilities. Nearly a century later, these mathematical oddities have been confirmed astrophysically in the existence of black holes, an expanding universe, and a big bang. The course will cover Einstein's General Theory, beginning with special relativity, with an emphasis on black holes and the big bang.

Physics Courses

PHYS BC2001 Physics I: Mechanics. *4.5 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA)., Lab Required

Corequisites: Calculus I or the equivalent.
Fundamental laws of mechanics. Kinematics, Newton's laws, work and energy, conservation laws, collisions, rotational motion, oscillations, gravitation.

Fall 2021: PHYS BC2001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 2001	001/00155	T Th 10:10am - 11:25am 323 Milbank Hall	Janna Levin, Stiliana Savin	4.5	34/100

PHYS BC2002 Physics II: Electricity and Magnetism. *4.5 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA)., Lab Required

Prerequisites: Physics BC2001 or the equivalent.
Corequisites: Calculus II.
Charge, electric field, and potential. Gauss's law. Circuits: capacitors and resistors. Magnetism and electromagnetism. Induction and inductance. Alternating currents. Maxwell's equations.

Spring 2021: PHYS BC2002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 2002	001/00525	T Th 10:10am - 11:25am Room TBA	Janna Levin	4.5	35

PHYS BC3001 Physics III: Classical Waves & Optics. *5 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA)., Lab Required

Prerequisites: Physics BC2002 or the equivalent.
Corequisites: Calculus III.
Nonlinear pendula, transverse vibrations-elastic strings, longitudinal sound waves, seismic waves, electromagnetic oscillations & light, rainbows, haloes, the Green Flash; polarization phenomena - Haidinger's Brush, Brewster's angle, double refraction, optical activity; gravity & capillary waves; interference, diffraction, lenses & mirrors.

Fall 2021: PHYS BC3001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3001	001/00145	T Th 8:40am - 9:55am 530 Altschul Hall	Timothy Halpin-Healy, Margaret Kaye	5	9/15

PHYS BC3006 Quantum Physics. *3 points*.
Prerequisites: BC3001 or C2601 or the equivalent.
Wave-particle duality and the Uncertainty Principle. The Schrodinger equation. Basic principles of the quantum theory. Energy levels in one-dimensional potential wells. The harmonic oscillator, photons, and phonons. Reflection and transmission by one-dimensional potential barriers. Applications to atomic, molecular, and nuclear physics.

Spring 2021: PHYS BC3006

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3006	001/00488	T Th 10:10am - 11:25am 805 Altschul Hall	Reshmi Mukherjee	3	8
PHYS 3006	001/00488	T Th 8:40am - 9:25am 805 Altschul Hall	Reshmi Mukherjee	3	8

PHYS BC3082 Advanced Physics Laboratory. *1.5 point*.
Barnard College physics laboratory has available a variety of experiments meant to complement 3000-level lecture courses. Each experiment requires substantial preparation, as well as written and oral presentations. Elementary particle experiments: detectors, cosmic ray triggers, muon lifetime.

PHYS BC3086 Quantum Physics Laboratory. *3 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA).

Experiments illustrating phenomenological aspects of the early quantum theory: (i) Hydrogenic Spectra: Balmer Series & Bohr-Sommerfeld Model; (ii) Photoelectric Effect: Millikan's Determination of h/e; (iii) Franck-Hertz Experiment; and (iv) Electron Diffraction Phenomena. Substantial preparation required, including written and oral presentations, as well as an interest in developing the knack and intuition of an experimental physicist. This course is best taken concurrently with PHYS BC3006 *Quantum Physics*.

Spring 2021: PHYS BC3086

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3086	001/00489		Reshmi Mukherjee	3	5

PHYS BC3088 Advanced Electromagnetism Laboratory. *3 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA).

Classical electromagnetic wave phenomena via Maxwell's equations, including: (i) Michaelson and Fabry-Perot Interferometry, as well as a thin-film interference and elementary dispersion theory; (ii) Fraunhofer Diffraction (and a bit of Fresnel); (iii) Wireless Telegraphy I: AM Radio Receivers; and (iv) Wireless Telegraphy II: AM Transmitters. Last two labs pay homage to relevant scientific developments in the period 1875-1925, from the discovery of Hertzian waves to the Golden Age of Radio. Complements PHYS W3008 *Electromagnetic Waves and Optics*.

Spring 2021: PHYS BC3088

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3088	001/00596	F 10:30am - 12:00pm Room TBA	Stiliana Savin	3	5/15

Fall 2021: PHYS BC3088

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3088	001/00148	F 10:30am - 12:00pm Room TBA	Stiliana Savin	3	6/15

PHYS BC3900 Supervised Individual Research. *1-5 points*.
BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA).
1-5 points per term.

Prerequisites: Permission of the departmental representative required. For specially selected students, the opportunity to do a research problem in contemporary physics under the supervision of a faculty member. Each year several juniors are chosen in the spring to carry out such a project beginning in the autumn term. A detailed report on the research is presented by the student when the project is complete.

Fall 2021: PHYS BC3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3900	001/00149		Reshmi Mukherjee	1-5	1

PHYS UN1001 Physics for Poets. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: high school algebra.
This course does not fulfill the physics requirement for admission to medical school. No previous background in physics is expected. An introduction to physics taught through the exploration of the scientific method, and the application of physical principles to a wide range of topics from quantum mechanics to cosmology.

Spring 2021: PHYS UN1001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1001	001/10222	M W 2:40pm - 3:55pm Online Only	Szabolcs Marka	3	92/150

PHYS UN1201 General Physics I. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: some basic background in calculus or be concurrently taking MATH UN1101 Calculus I.,The accompanying laboratory is PHYS UN1291-UN1292
The course will use elementary concepts from calculus. The accompanying laboratory is *PHYS UN1291 - UN1292.* Basic introduction to the study of mechanics, fluids, thermodynamics, electricity, magnetism, optics, special relativity, quantum mechanics, atomic physics, and nuclear physics.

Spring 2021: PHYS UN1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1201	001/10189	T Th 5:40pm - 6:55pm Online Only	P. Michael Tuts	3	137/200

Fall 2021: PHYS UN1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1201	001/11931	M W 10:10am - 11:25am 301 Pupin Laboratories	Cory Dean	3	167/180
PHYS 1201	002/11932	T Th 5:40pm - 6:55pm 301 Pupin Laboratories	P. Michael Tuts	3	122/180

PHYS UN1202 General Physics II. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: This course will use elementary concepts from calculus. Students should therefore have had some high school calculus, or be concurrently enrolled in MATH UN1101. Taken with accompanying lab PHYS UN1291- PHYS UN1292, the sequence PHYS UN1201- PHYS UN1202 satisfies requirements for medical school.
Electricity, magnetism, optics, and modern physics.

Spring 2021: PHYS UN1202

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1202	001/10190	M W 10:10am - 11:25am Online Only	Michael Shaevitz	3	146/200
PHYS 1202	002/12972	M W 5:40pm - 6:55pm Online Only	Eric Raymer	3	112/120

Summer 2021: PHYS UN1202

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1202	002/11140	M W 6:15pm - 7:30pm Online Only	Rebecca Grossman	3	47/70

PHYS UN1291 General Physics Laboratory. *1 point*.
Same course as *PHYS W1291x*, but given off-sequence.

Corequisites: PHYS UN1201
This course is the laboratory for the corequisite lecture course and can be taken only during the same term as the corresponding lecture.

Spring 2021: PHYS UN1291

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1291	001/10191	M 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	14/15
PHYS 1291	002/10192	M 4:10pm - 7:10pm Online Only	Giuseppina Cambareri	1	11/15
PHYS 1291	003/10193	T 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	14/15
PHYS 1291	004/10194	T 7:30pm - 10:30pm Online Only	Giuseppina Cambareri	1	10/15
PHYS 1291	005/10195	W 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	10/15
PHYS 1291	006/10196	W 4:10pm - 7:10pm Online Only	Giuseppina Cambareri	1	10/15
PHYS 1291	007/10197	Th 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	11/15
PHYS 1291	008/10198	M 7:30pm - 10:30pm Online Only	Giuseppina Cambareri	1	7/15
PHYS 1291	010/18017	F 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	13/15

Fall 2021: PHYS UN1291

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1291	001/11977	M 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	14/15
PHYS 1291	002/11978	M 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	11/15
PHYS 1291	003/11979	M 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	11/15
PHYS 1291	004/11980	M 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	15/15
PHYS 1291	005/11981	M 7:30pm - 10:30pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	12/15
PHYS 1291	007/11982	T 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	13/15
PHYS 1291	008/11983	T 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	13/15
PHYS 1291	009/11984	T 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	14/15
PHYS 1291	011/11986	T 7:30pm - 10:30pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	11/15
PHYS 1291	013/11988	W 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	11/15
PHYS 1291	014/11989	W 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	13/15
PHYS 1291	015/11990	W 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	13/15
PHYS 1291	016/11991	W 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	13/15
PHYS 1291	017/11992	W 7:30pm - 10:30pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	10/15
PHYS 1291	019/11993	Th 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	12/15
PHYS 1291	020/11994	Th 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	14/15
PHYS 1291	021/11995	Th 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	12/15
PHYS 1291	023/11997	Th 7:30pm - 10:30pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	7/15
PHYS 1291	025/11998	F 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	12/15
PHYS 1291	026/12000	F 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri	1	13/15

PHYS UN1292 General Physics Laboratory II. *1 point*.
Corequisites: PHYS UN1201,PHYS UN1202
This course is the laboratory for the corequisite lecture course (*PHYS UN1201 - PHYS UN1202*) and can be taken only during the same term as the corresponding lecture.

Spring 2021: PHYS UN1292

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1292	001/10199	M 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	15/15
PHYS 1292	002/16491	M 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	15/15
PHYS 1292	007/10202	T 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	008/16493	T 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	009/10203	T 4:10pm - 7:10pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	010/16494	T 4:10pm - 7:10pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	011/10204	T 7:30pm - 10:30pm Online Only	Giuseppina Cambareri	1	14/15
PHYS 1292	013/10205	W 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	14/15
PHYS 1292	014/16495	W 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	015/10206	W 4:10pm - 7:10pm Online Only	Giuseppina Cambareri	1	15/15
PHYS 1292	017/10207	W 7:30pm - 10:30pm Online Only	Giuseppina Cambareri	1	12/15
PHYS 1292	018/10208	Th 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	14/15
PHYS 1292	019/16497	Th 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	020/10209	Th 4:10pm - 7:10pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	022/10210	Th 7:30pm - 10:30pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	023/10211	F 1:00pm - 4:00pm Online Only	Giuseppina Cambareri	1	12/15

Summer 2021: PHYS UN1292

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1292	001/10291	M 1:00pm - 4:10pm Online Only	Giuseppina Cambareri	1	5/15
PHYS 1292	002/11142	T 1:00pm - 4:10pm Online Only	Giuseppina Cambareri	1	14/15
PHYS 1292	003/11143	W 1:00pm - 4:10pm Online Only	Giuseppina Cambareri	1	13/15
PHYS 1292	004/11144	Th 1:00pm - 4:10pm Online Only	Giuseppina Cambareri	1	14/15

PHYS UN1401 Introduction To Mechanics and Thermodynamics. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Corequisites: MATH UN1101
Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, temperature and heat, gas laws, the first and second laws of thermodynamics.
Corequisite: MATH UN1101 or the equivalent.

Spring 2021: PHYS UN1401

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1401	001/10213	T Th 10:10am - 11:25am Online Only	Emlyn Hughes	3	82/200

Fall 2021: PHYS UN1401

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1401	001/11935	M W 1:10pm - 2:25pm 301 Pupin Laboratories	Jeremy Dodd	3	170/170
PHYS 1401	002/11937	T Th 10:10am - 11:25am 301 Pupin Laboratories	Tanya Zelevinsky	3	166/170

PHYS UN1402 INTRO ELEC/MAGNETSM # OPTCS. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: PHYS UN1401
Corequisites: MATH UN1102
Prerequisites: PHYS W1401. Corequisites: MATH V1102 or the equivalent.
Electric fields, direct currents, magnetic fields, alternating currents, electromagnetic waves, polarization, geometrical optics, interference, and diffraction

Spring 2021: PHYS UN1402

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1402	001/10212	T Th 10:10am - 11:25am Online Only	Georgia Karagiorgi	3.00	188/200

PHYS UN2801 Accelerated Physics I. *4.5 points*.
Prerequisites: Advanced Placement in physics and mathematics, or the equivalent, and the instructor's permission. (A special placement meeting is held during Orientation.)
This accelerated two-semester sequence covers the subject matter of *PHYS UN1601*, *PHYS UN1602* and *PHYS UN2601*, and is intended for those students who have an exceptionally strong background in both physics and mathematics. The course is preparatory for advanced work in physics and related fields. There is no accompanying laboratory; however, students are encouraged to take the intermediate laboratory, *PHYS UN3081*, in the following year.

Fall 2021: PHYS UN2801

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 2801	001/11941	T Th 10:10am - 12:00pm 329 Pupin Laboratories	Norman Christ	4.5	44/100

PHYS UN2802 Accelerated Physics II. *4.5 points*.
Prerequisites: PHYS UN2801
This accelerated two-semester sequence covers the subject matter of *PHYS UN1601*, *PHYS UN1602* and *PHYS UN2601*, and is intended for those students who have an exceptionally strong background in both physics and mathematics. The course is preparatory for advanced work in physics and related fields. There is no accompanying laboratory; however, students are encouraged to take the intermediate laboratory, *PHYS UN3081*, in the following year.

Spring 2021: PHYS UN2802

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 2802	001/10225	T Th 10:10am - 12:00pm Online Only	Norman Christ	4.5	32/70

PHYS UN3003 Mechanics. *3 points*.
Prerequisites: general physics, and differential and integral calculus.
Newtonian mechanics, oscillations and resonance, conservative forces and potential energy, central forces, non-inertial frames of reference, rigid body motion, an introduction to Lagrange's formulation of mechanics, coupled oscillators, and normal modes.

Spring 2021: PHYS UN3003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3003	001/10226	M W 10:10am - 11:25am Online Only	John Parsons	3	48/70

PHYS UN3007 Electricity and Magnetism. *3 points*.
Prerequisites: general physics, and differential and integral calculus.
Electrostatics and magnetostatics, Laplace's equation and boundary-value problems, multipole expansions, dielectric and magnetic materials, Faraday's law, AC circuits, Maxwell's equations, Lorentz covariance, and special relativity.

Fall 2021: PHYS UN3007

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3007	001/11942	M W 11:40am - 12:55pm 329 Pupin Laboratories	Alfred Mueller, Giuseppina Cambareri	3	53/100

PHYS UN3008 Electromagnetic Waves and Optics. *3 points*.
Prerequisites: PHYS UN3008
Maxwell's equations and electromagnetic potentials, the wave equation, propagation of plane waves, reflection and refraction, geometrical optics, transmission lines, wave guides, resonant cavities, radiation, interference of waves, and diffraction.

Spring 2021: PHYS UN3008

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3008	001/10227	M W 11:40am - 12:55pm 428 Pupin Laboratories	Alfred Mueller, Giuseppina Cambareri	3	55/70

PHYS UN3083 Electronics Laboratory. *3 points*.
Enrollment limited to the capacity of the laboratory.

Prerequisites: PHYS UN3003 or PHYS UN3007 May be taken before or concurrently with this course.
A sequence of experiments in solid-state electronics, with introductory lectures.

Spring 2021: PHYS UN3083

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3083	001/10232	M W 1:10pm - 4:00pm 329 Pupin Laboratories	John Parsons	3	7/12

PHYS GU4003 Advanced Mechanics. *3 points*.
Prerequisites: differential and integral calculus, differential equations, and PHYS UN3003 or the equivalent.
Lagrange's formulation of mechanics, calculus of variations and the Action Principle, Hamilton's formulation of mechanics, rigid body motion, Euler angles, continuum mechanics, introduction to chaotic dynamics.

Spring 2021: PHYS GU4003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4003	001/10235	M W 4:10pm - 5:25pm Online Only	James Hill	3	24/45

PHYS GU4021 Quantum Mechanics I. *3 points*.
Prerequisites: PHYS UN3003 and PHYS UN3007
Formulation of quantum mechanics in terms of state vectors and linear operators. Three dimensional spherically symmetric potentials. The theory of angular momentum and spin. Identical particles and the exclusion principle. Methods of approximation. Multi-electron atoms.

Fall 2021: PHYS GU4021

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4021	001/11949	T Th 11:40am - 12:55pm 627 Seeley W. Mudd Building	William Zajc	3	56/100

PHYS GU4022 Quantum Mechanics II. *3 points*.
Prerequisites: PHYS GU4021. Formulation of quantum mechanics in terms of state vectors and linear operators, three-dimensional spherically symmetric potentials, the theory of angular momentum and spin, time-independent and time-dependent perturbation theory, scattering theory, and identical particles.Selected phenomena from atomic physics, nuclear physics, and elementary particle physics are described and then interpreted using quantum mechanical models.

Spring 2021: PHYS GU4022

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4022	001/10237	T Th 11:40am - 12:55pm 329 Pupin Laboratories	William Zajc	3	28/60

PHYS GU4023 Thermal and Statistical Physics. *3 points*.
Prerequisites: PHYS GU4021 or the equivalent.
Thermodynamics, kinetic theory, and methods of statistical mechanics; energy and entropy; Boltzmann, Fermi, and Bose distributions; ideal and real gases; blackbody radiation; chemical equilibrium; phase transitions; ferromagnetism.

Fall 2021: PHYS GU4023

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4023	001/11950	T Th 1:10pm - 2:25pm 329 Pupin Laboratories	Andrew Millis	3	23/100

Cross-Listed Courses

Physics

PHYS UN3002 From Quarks To the Cosmos: Applications of Modern Physics. *3.5 points*.
Not offered during 2021-22 academic year.

Prerequisites: PHYS UN2601 or PHYS UN2802
This course reinforces basic ideas of modern physics through applications to nuclear physics, high energy physics, astrophysics and cosmology. The ongoing Columbia research programs in these fields are used as practical examples. The course is preparatory for advanced work in physics and related fields.