Physics and Astronomy

Department Head: James A. Van Allen
Associate Department Head and Undergraduate Adviser: Edward B. Jealey

Degrees offered: B.A. and M.S. in Astronomy and Physics, Ph.D. in Physics

The Department of Physics and Astronomy provides comprehensive and rigorous instruction in all basic aspects of these subjects. In addition it provides research facilities and guidance for individual scholarly work at an advanced level in selected specialties.

Total Departmental enrollments are typically 900 student registrations during each semester of the academic year and 100 during the summer session. All courses and advanced laboratories are taught by full-time members of the faculty. Senior members of the faculty teach the elementary courses and supervise graduate student assistants who conduct the associated laboratories.

Beyond the elementary level, typical course enrollments are 25, and there is ample opportunity for individual work. Special introductory courses having similar enrollments are offered for majors in physics and others with special interest in the subject. There are about 50 undergraduate majors, half of whom are honors students, and 60 graduate students in physics or astronomy.

About 40 percent of the graduates with Bachelor of Arts degrees pursue advanced study, 25 percent find secondary school teaching posts and 35 percent go into temporary military service or find employment in government laboratories or in industry. Students in physics and astronomy usually have a higher average academic rank than those of any other department of the University.

Graduates of The University of Iowa with M.S. or Ph.D. degrees in physics or astronomy continue to find excellent employment in universities, colleges, and research laboratories in government and industry, despite a recent national shrinkage in such opportunities.

Undergraduate Major in Physics

The following courses or their equivalents are required for the Bachelor of Arts degree with a major in physics:

22M:25, 26, 27, 28 Calculus I, II, III and Introduction to Linear Algebra 16 s.h.

or

22M:35, 36, 37, 38 Engineering Mathematics I, II, III, IV 16 s.h.
29:17, 18, 19 12 s.h.
29:118 Kinetic Theory and Thermodynamics 3 s.h.
29:129, 130 Electricity and Magnetism 6 s.h.
29:132 Intermediate Laboratory 6 s.h.
29:191 Atomic Physics 3 s.h.
22M:130, 131 Elementary Theoretical Mechanics I, II 6 s.h.

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Physics and Astronomy

4:5, 4:6 Principles of Chemistry and Elementary Chemistry Laboratory 5 s.h.
or
4:8, 4:9 General Chemistry II and General Chemistry Laboratory 5 s.h.

Undergraduate majors who plan to pursue graduate study in physics are advised to:

- Take 29:171, 172 Methods of Theoretical Physics;
- Acquire reading facility in either Russian or German; and
- Go beyond the minimum requirements listed above to the greatest feasible extent.

Undergraduate Major in Astronomy

Astronomy includes the subdisciplines of astrophysics, classical astronomy, radio astronomy and space astronomy. A balanced and integrated program of astronomy, physics and mathematics courses is required for the Bachelor of Arts degree in astronomy. The purpose of this program is to prepare the student for a career or advanced study in astrophysics, radio astronomy or space astronomy.

The following courses or their equivalents are required for the Bachelor of Arts degree with a major in astronomy.

29:17, 18, 19 Introductory Physics I, II, III 12 s.h.
29:61, 62 General Astronomy 8 s.h.
29:119, 120 Introduction to Stellar Astrophysics I, II 6 s.h.
29:129, 130 Electricity and Magnetism 6 s.h.
29:132 Intermediate Laboratory 4 s.h.
29:137 Astronomical Laboratory 2 s.h.
29:191 Atomic Physics 3 s.h.
22M:130, 131 Elementary Theoretical Mechanics I, II 6 s.h.

Undergraduate majors in astronomy who plan to pursue graduate study in astrophysics are advised to:

- Go beyond the minimum requirements listed above to the greatest feasible extent;
- Take 29:117 Optics 3 s.h.
29:118 Kinetic Theory and Thermodynamics 3 s.h.
29:171, 172 Methods of Theoretical Physics; and
- Acquire reading facility in one or more of the following languages: Russian, German and French

Honors

Selected junior and senior majors take six to eight semester hours of 29:99 Honors Thesis and prepare an undergraduate thesis as part of their program for the degree Bachelor of Arts with Honors in Physics or in Astronomy.
For the general requirements of the College of Liberal Arts, see “College of Liberal Arts.”

Graduate Program

Two advanced degrees are offered in physics, the Master of Science (with or without thesis) and the Doctor of Philosophy; and one in astronomy, the Master of Science (with or without thesis). A student who wishes to pursue a program in astronomy beyond the M.S. level may qualify for a Doctor of Philosophy degree in physics with specialization and a dissertation in astronomy or astrophysics.

The Department of Physics and Astronomy cooperates in interdisciplinary doctoral programs with the Program in Applied Mathematical Sciences (see “Graduate College”).

An interdepartmental program leading to the M.S. and Ph.D. degrees in chemical physics is also available.

Each entering graduate student is assigned to a faculty adviser who will assist him or her in preparing a plan of study and in guiding the student’s progress. A graduate student becomes a candidate for an advanced degree in physics or astronomy only after passing a qualifying examination in all principal areas of the subject at the level of advanced undergraduate work. The examination is given during the first week of the second semester each year and must be taken by all first-year-graduate students. Ordinarily, a candidate for any advanced degree should begin research in a chosen specialty during the second year of residency. The thesis or essay adviser then becomes the candidate’s general adviser and the chairman of his or her final examination committee.

For the general admission and degree requirements, see “Graduate College.”

Master of Science Degree in Physics

The M.S. degree is offered with thesis or without thesis. Either degree may be an intermediate step toward a Ph.D. degree, or it may be a terminal degree. The final examination in either case is an oral one conducted by a committee of three members of the graduate faculty appointed by the dean of the Graduate College.

The program for the M.S. degree with thesis requires 30 semester hours of graduate work and a thesis based on an original experimental or theoretical investigation by the candidate. No more than six of the minimal 30 semester hours may be for research (29:281).

The program for the M.S. degree without thesis requires 30 semester hours of graduate work, an independent study of the literature on a chosen topic and the preparation of a critical essay on that topic. No more than four of the minimal 30 semester hours may be for the critical essay (29:220). Up to one-third of the graduate program may be in related scientific fields other than physics and mathematics, e.g., chemistry, astronomy, engineering, etc.

The candidate for either of the M.S. degrees must have satisfactorily completed the following courses or their equivalents as an undergraduate or a graduate:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>29:117</td>
<td>Optics</td>
<td>3</td>
</tr>
<tr>
<td>29:118</td>
<td>Kinetic Theory and Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>22M:130, 131</td>
<td>Elementary Theoretical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>29:129, 130</td>
<td>Electricity and Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>29:133</td>
<td>Advanced Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>29:171, 172</td>
<td>Methods of Theoretical Physics</td>
<td>3</td>
</tr>
<tr>
<td>29:191</td>
<td>Atomic Physics</td>
<td>3</td>
</tr>
<tr>
<td>29:192</td>
<td>Nuclear Physics</td>
<td>3</td>
</tr>
<tr>
<td>29:193</td>
<td>Introductory Solid State Physics</td>
<td>3</td>
</tr>
</tbody>
</table>
Physics and Astronomy

The student's plan of study should provide for as much advanced work as aptitude and previous preparation permit.

Master of Science Degree in Astronomy
The M.S. degree is offered with thesis or without thesis. The requirements for the two degrees are the same as for the corresponding degrees in physics (see above), with these changes:

**Delete:**
- 29:133 Advanced Laboratory 4 s.h.
- 29:192 Nuclear Physics 3 s.h.
- 29:193 Introductory Solid State Physics 3 s.h.

**Add:**
- 29:119, 120 Introduction to Stellar Astrophysics I, II 6 s.h.
- 29:121 Solar System Astrophysics 3 s.h.
- 29:133 Advanced Laboratory 2 s.h.
- 29:137 Astronomical Laboratory 2 s.h.

If the student intends to continue for a Ph.D. in physics with an astrophysics specialization he or she should take the following courses as soon as possible:

- 29:131 Radio Astronomy 3 s.h.
- 29:232, 233 Theoretical Astrophysics I, II 6 s.h.
- 29:234 Stellar Structure and Evolution 4 s.h.
- 29:235 Special Topics in Planetary and Space Science 2 s.h.
- 29:263 Seminar: Astrophysics cr. arr.

Doctor of Philosophy Degree in Physics
The program of study for the Ph.D. degree with major in physics includes:

- Thorough coursework in both classical and modern theoretical physics for all candidates, whether their specialization research is to be in an experimental or a theoretical area;
- Comprehensive examinations;
- Participation in advanced seminars;
- Original research in experimental physics, theoretical physics or astrophysics; and the preparation of a written dissertation based on this work; and
- Successful defense of the dissertation in a final oral examination conducted by a committee of five members of the Graduate Faculty appointed by the dean of the Graduate College.

Emphasis is on the capabilities developed and knowledge gained rather than on the particular courses taken, credits acquired or other aspects of the means to the end. Although no specific courses are required, the following are recommended as preparation for the comprehensive examinations:

- 29:191, 192, 193 Atomic Physics, Nuclear Physics and Introductory Solid State Physics
- 29:205 Classical Mechanics
- 29:212 Statistical Mechanics I
- 29:213, 214 Classical Electrodynamics
- 29:245, 246 Quantum Mechanics I, II

Advanced mathematics, such as the theory of functions of a complex variable and vector and tensor analysis, is used freely in these courses. An introduction to these fields is given in 28:171, 172 Methods of Theoretical Physics. The selection of the advanced courses will depend on the adequacy of the student's preparation for graduate work; the student's choice of more advanced and specialized courses will depend on the direction in which his or her interests develop.

Before a Ph.D. candidate is admitted to the comprehensive examinations, he or she must demonstrate a reading competence in French, German or Russian by passing the reading examination administered by the appropriate language department; or by having satisfactorily completed 12 or more semester hours of collegiate coursework (or the equivalent) in any one of the above three foreign languages. Students whose native language is not English will be considered as special cases.

A candidate for the Ph.D. degree will not be recommended for the degree until he or she has written the dissertation in proper form for formal publication and has submitted it, with the approval of the research adviser, for publication to a standard scientific journal of wide distribution.

Research
The Department has an excellent library and a number of well-equipped laboratories and observatories. An IBM 360/65 digital computer and the associated facilities of the University Computer Center are available for research by students and staff of the Department. Several other smaller computers are available within the Department. The central machine shop is fully equipped and staffed with skilled instrument makers and machinists, and there are several electronics and machine shops for the use of advanced students and the research staff.

Experimental research is conducted in the fields of nuclear structure physics, ionospheric and space physics, astrophysics, solar and planetary physics, chemical physics and solid state physics.

Theoretical research is devoted to atomic and nuclear theory, quantum field theory, statistical mechanics, plasma physics, theory of solids, theory of elementary particles, solar terrestrial physics and astrophysics.

Exceptional opportunities are available for experimental research in space physics.

Persons qualified for graduate study are invited to apply for fellowships and assistantships. Inquiries should be directed to the head of the Department.

Staff: professors Carlson, Frank, Montgomery, Nelson, NORbeck, Van Allen; professors emirii Tyndall, Wylie; associate professors Carpenter, Garnett, Herzhakowitz, Kinkel, Knorr, McClintom, Neff, Savage; assistant professors Fix, Joyce, Payne, Schlesinger, Schweitzer, Shawan; visiting associate professor Daniel W. Swift; research assistant professor Enemark

Courses

Physics
Prerequisites and corequisites specified as guide and may be waived by instructor; students may not repeat for either credit or quality points an elementary course if they have already completed higher level course for which elementary course, or its equivalent, is prerequisite; core courses: 29:1, 2 College Physics, eight semes-
Physics and Astronomy

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>29:133</td>
<td>Advanced Laboratory</td>
<td>2 s.h.</td>
</tr>
<tr>
<td></td>
<td>Laboratory work in optical spectroscopy, solid state, nuclear physics and cosmic rays; one laboratory period each week; may be repeated</td>
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<tr>
<td>29:149</td>
<td>Introductory Quantum Mechanics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Introductory course for majors in physics, astronomy, chemistry and other sciences</td>
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</tr>
<tr>
<td>29:150</td>
<td>Cultural Issues in Physics</td>
<td>2 s.h.</td>
</tr>
<tr>
<td></td>
<td>Interaction of physics with larger cultural matrix in which embedded; modern history of physics; physics and politics; structure and function of scientific establishments; impact of physics on aesthetics; ethics and physical sciences; for graduates and advanced undergraduates with and without background in physical science; no mathematics required; content can vary</td>
<td></td>
</tr>
<tr>
<td>29:157</td>
<td>Physics for Artists</td>
<td>2 s.h.</td>
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<tr>
<td></td>
<td>Discussion and laboratory course for nonscience students; study of properties of many different kinds of waves leading to understanding of holography; no prerequisites</td>
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<tr>
<td>29:158</td>
<td>Physics for Artists</td>
<td>2 s.h.</td>
</tr>
<tr>
<td></td>
<td>Continuation of 29:157 which, however, is not prerequisite; study of many aspects of production and detection of color; no prerequisites</td>
<td></td>
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<tr>
<td>29:171</td>
<td>Methods of Theoretical Physics</td>
<td>3 s.h.</td>
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<tr>
<td></td>
<td>Functions of complex variable, integration methods, linear vector spaces and matrix algebra; prerequisite: Mathematics 22M:28 or 22M:38</td>
<td></td>
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<tr>
<td>29:172</td>
<td>Methods of Theoretical Physics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Continuation of 29:171; Hilbert space, special functions, Fourier transform and expansions in orthogonal polynomials, differential equations and Green’s functions</td>
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<tr>
<td>29:191</td>
<td>Atomic Physics</td>
<td>3 s.h.</td>
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<td></td>
<td>Introductory quantum theory and wave mechanics, atomic and molecular spectra, atomic structure; prerequisites: 29:19 and Mathematics 22M:37 or equivalent; see 29:133 for laboratory work</td>
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<tr>
<td>29:192</td>
<td>Nuclear Physics</td>
<td>3 s.h.</td>
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<tr>
<td></td>
<td>Nuclear masses, radioactivity, alpha-, beta-, and gamma-ray spectra, nuclear energy levels and nuclear structure, nuclear reactions, the neutron, fission and fusion reactions, passage of radiations through matter, mesons and elementary particles, experimental techniques; prerequisite: 29:191 or equivalent; see 29:133 for laboratory work</td>
<td></td>
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<tr>
<td>29:193</td>
<td>Introductory Solid State Physics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Phenomenological and theoretical properties of solids; classification of solids and crystal structures, electronic and vibrational processes in materials; thermal, optical, magnetic and dielectric properties of solids; prerequisites: 29:19 and Mathematics 22M:37 or equivalent; see 29:133 for laboratory work</td>
<td></td>
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<tr>
<td>29:194</td>
<td>Plasma Physics</td>
<td>3 s.h.</td>
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<tr>
<td></td>
<td>Physics of ionized gases including orbit theory, guiding center motion, adiabatic invariants, description of plasmas by fluid variables and distribution functions; linearized wave motions and instabilities; magnetohydrodynamics and MHD shock waves; prerequisites: 29:130 and knowledge of vector analysis</td>
<td></td>
</tr>
<tr>
<td>29:195</td>
<td>Plasma Physics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Continuation of 29:194; linear and nonlinear solutions of the Vlasov equation, test charge problems and Fokker-Planck equation</td>
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</tbody>
</table>

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**Primarily for Undergraduates**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>29:1</td>
<td>College Physics</td>
<td>4 s.h.</td>
</tr>
<tr>
<td></td>
<td>Open to freshmen; for premedical, predental and pharmacy students and others interested in elementary physics; descriptive lectures, laboratory and problem work in mechanics, heat and sound; prerequisite or corequisite: Mathematics 22M:2 or equivalent; both semesters and summer session</td>
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<tr>
<td>29:2</td>
<td>College Physics</td>
<td>4 s.h.</td>
</tr>
<tr>
<td></td>
<td>Continuation of 29:1, which is prerequisite; electricity, magnetism, light and modern physics; both semesters and summer session</td>
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</tr>
<tr>
<td>29:9:3</td>
<td>Quantum Physics I</td>
<td>4 s.h.</td>
</tr>
<tr>
<td></td>
<td>Mechanics, heat and sound; three lecture-discussion sessions and one laboratory per week; recommended for majors in physics, astronomy and other sciences and for Honors students; corequisite: Mathematics 22M:25 or 22M:35</td>
<td></td>
</tr>
<tr>
<td>29:10</td>
<td>Quantum Physics II</td>
<td>4 s.h.</td>
</tr>
<tr>
<td></td>
<td>Electricity, magnetism and light; continuation of 29:17</td>
<td></td>
</tr>
<tr>
<td>29:19</td>
<td>Quantum Physics III</td>
<td>4 s.h.</td>
</tr>
<tr>
<td></td>
<td>Atomic and nuclear physics and relativity; continuation of 29:18</td>
<td></td>
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<tr>
<td>29:22</td>
<td>Quantum Physics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Unifying principles of classical and modern physics; mechanics, electricity, magnetism and wave phenomena; introduction to quantum mechanics; primarily for junior engineering students</td>
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</tr>
<tr>
<td>29:82</td>
<td>Physics II</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Continuation of 29:81; atomic and nuclear physics; other applications of fundamental concepts to modern physics; primarily for senior engineering students</td>
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<tr>
<td>29:83</td>
<td>Physics II</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Continuation of 29:82; atomic and nuclear physics; other applications of fundamental concepts to modern physics; primarily for senior engineering students</td>
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</tr>
<tr>
<td>29:98</td>
<td>Undergraduate Seminar</td>
<td>cr. arr.</td>
</tr>
<tr>
<td></td>
<td>Consult head of Department before registering</td>
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<tr>
<td>29:99</td>
<td>Honors Seminar</td>
<td>1 s.h.</td>
</tr>
<tr>
<td></td>
<td>Reading and discussion on selected topics in physics or astronomy under guidance of instructor; topic and instructor announced in advance of each semester; may be repeated</td>
<td></td>
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<tr>
<td>29:99</td>
<td>Honors Thesis</td>
<td>cr. arr.</td>
</tr>
<tr>
<td></td>
<td>Supervised original research project leading to written report and oral defense; for junior and senior Honors candidates majoring in physics or astronomy</td>
<td></td>
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</tbody>
</table>

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**For Undergraduates and Graduates**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>29:102</td>
<td>Reading in Physics</td>
<td>cr. arr.</td>
</tr>
<tr>
<td></td>
<td>Consult head of Department before registering</td>
<td></td>
</tr>
<tr>
<td>29:113</td>
<td>Physics of Sound and Music</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Properties of sound waves and propagation, reflection and absorption; production of sound by voice and musical instruments; musical scales; mechanical and electronic generation, recording and reproduction of sound; descriptive course; no mathematical prerequisites</td>
<td></td>
</tr>
<tr>
<td>29:117</td>
<td>Optics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Geometrical and physical optics; properties of lenses and simple optical instruments; phenomena of propagation, interference, diffraction and polarization of light; see 29:132 for laboratory work</td>
<td></td>
</tr>
<tr>
<td>29:118</td>
<td>Kinetic Theory and Thermodynamics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Kinetic theory of matter; macroscopic description of thermal phenomena; fundamental laws of thermodynamics and application</td>
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<tr>
<td>29:127</td>
<td>Electricity and Electrical Measurements</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Electromagnetic fields and measurements; introduction to electromagnetic fields; two lectures and one laboratory each week; prerequisites: 29:2 or 29:18 and Mathematics 22M:26 or 22M:36</td>
<td></td>
</tr>
<tr>
<td>29:128</td>
<td>Electronics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Characteristics of transistors and semiconductor devices; design and study of analog and digital circuits; two lectures and one laboratory each week; prerequisite: 29:127 or equivalent</td>
<td></td>
</tr>
<tr>
<td>29:129</td>
<td>Electricity and Magnetism</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Electrostatics, magnetic fields, electromagnetic induction and introduction to Maxwell’s equations; see 29:132 for laboratory work; prerequisite: Mathematics 22M:37 or equivalent</td>
<td></td>
</tr>
<tr>
<td>29:130</td>
<td>Electricity and Magnetism</td>
<td>3 s.h.</td>
</tr>
<tr>
<td></td>
<td>Magnetic properties of materials, electromagnetic waves and applications of Maxwell’s equations to wave guides, optics, plasma physics and other selected topics; continuation of 29:129, which is prerequisite; see 29:132 for laboratory work</td>
<td></td>
</tr>
<tr>
<td>29:132</td>
<td>Intermediate Laboratory</td>
<td>2 s.h.</td>
</tr>
<tr>
<td></td>
<td>Laboratory work in electricity, magnetism and electronics; atomic, nuclear and solid state physics; optics; spectroscopy; one laboratory period each week; may be repeated</td>
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</tbody>
</table>
Physics and Astronomy

29:245 Quantum Mechanics I 3 a.h.
Noetherian quantum mechanics; Schrödinger wave mechanics, Hilbert space methods; perturbation theory; scattering; spin and angular momentum; identical particles; selected applications; introduction to relativistic theory; prerequisites: 29:191, 171, 172

29:246 Quantum Mechanics II 3 s.h.
Continuation of 29:245

29:249 Advanced Nuclear Physics 3 s.h.
Phenomena of nuclear physics and their interpretation; static properties of nuclei, nuclear moments, shell model, collective model, γ transitions, β decay, nuclear reaction mechanisms and other topics; prerequisites: 29:191, 192 and 245; may be repeated

29:250 Advanced Nuclear Physics 3 a.h.
Continuation of 29:249

Discussion of current research

Discussion of current research

29:264 Seminar: Teaching of Physics and Astronomy cr. arr.
Discussion of methods, techniques and organization

29:265 Seminar: Theoretical Physics cr. arr.
Discussion of current research

29:266 Seminar: Space Physics cr. arr.
Discussion of current research

29:267 Seminar: Nuclear Physics cr. arr.
Discussion of current research

29:269 Special Topics in Nuclear Physics cr. arr.
Advanced lectures on one or more of following topics: nuclear models, theory of nuclear reactions, weak interactions and heavy ion reactions; prerequisites: 29:249, 250; may be repeated

29:271 Theoretical Solid State Physics 3 s.h.
Central principles of quantum theory of solids; lattice dynamics, electronic properties, many-body effects, superconductivity, magnetism and other topics; emphasis on viewpoint of elementary excitations; prerequisites: 29:193, 243, 246

29:272 Theoretical Solid State Physics 3 s.h.
Continuation of 29:271; may be repeated

29:273 Relativity 3 s.h.
Relativistic formulation of mechanics and electrodynamics; Einstein’s theory of gravitation; may be repeated

29:274 Statistical Mechanics II 3 s.h.
Advanced topics in statistical mechanics; content may vary from year to year, e.g., foundations of kinetic theory and nonequilibrium statistical mechanics or quantum statistical mechanics; may be repeated

29:276 Special Topics in Quantum Mechanics 3 s.h.
Contemporary topics in quantum theory; field theory, dispersion relations, group theoretic analysis of fundamental particle classification schemes, Regge poles and many-body problems; topics discussed vary from year to year; prerequisites: 29:245, 246; may be repeated

29:278 Solar-Terrestrial Physics 2 s.h.
Phenomenon in solar atmosphere; corpuscular and electromagnetic radiation in interplanetary space; geomagnetic field and interplanetary magnetic storms; magnetic storms; aurora and geomagnetically trapped radiation; may be repeated

29:281 Research in Physics cr. arr.
Prerequisite: consent of head of department

29:290 Physics and Chemistry of the Upper Atmosphere 2 s.h.
Physics of neutral and ionized gases; absorption of solar radiation in relation to ionosphere, ozone layer and chemical processes in ionosphere; electric currents associated with daily magnetic variations and magnetic storms; may be repeated

29:294 Advanced Plasma Physics I 3 s.h.
Statistical mechanics of plasmas; Loewenstein equation, BBGKY hierarchy; Folkker-Planck equation and relaxation processes; Balescu-Leador equation; Vlasov equation and linearized wave motion; shocks, nonlinear plasma motions and instabilities; fluctuations and radiation processes; magnetohydrodynamics; recent papers; prerequisites: 29:212, 213 or consent of instructor; may be repeated

29:295 Advanced Plasma Physics II 3 s.h.
Continuation of 29:294; may be repeated

Astronomy
See explanatory notes under Physics section

Primarily for Undergraduates

29:61 General Astronomy 3 or 4 s.h.
Open to freshmen; descriptive lectures and study of astronomical techniques and of all components of solar system; introductory level; sun, earth, moon, planets and satellites, meteors, comets, energetic particles and interplanetary medium; also man-made spacecraft and current space investigations; course taken either with (four semester hours) or without (three semester hours) weekly laboratory for observational work with telescopes and problem work; prerequisites: at least one year each high school algebra and geometry

29:62 General Astronomy 3 or 4 s.h.
Continuation of 29:61 which, however, is not prerequisite; stellar astronomy, motions and physics of stars, systems of stars, interstellar matter and galaxies; prerequisites: same as for 29:61

29:64 Reading in Astronomy cr. arr.
Consult head of Department before registering

29:98 Undergraduate Seminar See “Physics” 1 s.h.

29:99 Honors Thesis See “Physics” cr. arr.

For Undergraduates and Graduates

29:104 Reading in Astronomy cr. arr.
Consult head of Department before registering

29:105 General Astronomy 4 s.h.
Abridged course offered only in summer session and on Saturdays during academic year; prerequisite: same as for 29:61; primarily for secondary and high school teachers of science

29:110 Introduction to Stellar Astrophysics I 3 s.h.
Fundamentals of astronomy and stellar spectroscopy; properties of visual, spectroscopic and eclipsing binary stars; stellar atmospheres and interiors; stellar kinematics and dynamics; distance indicators and application to investigation of structure of galaxy and extragalactic systems; prerequisites: 29:18 and Mathematics 22M:26 or 22M:36 or equivalent; alternate years; offered 1972–73

29:120 Introduction to Stellar Astrophysics II 3 s.h.
Continuation of 29:119; prerequisites: 29:19 and Mathematics 22M:26 or 22M:36 or equivalent; alternate years; offered 1972–73

29:121 Solar System Astrophysics 3 s.h.
Planetary surfaces, interiors and atmospheres; comets, meteors and asteroids; interplanetary environment; moon; origin and evolution of solar system; prerequisites: 29:19 and Mathematics 22M:26 or 22M:36 or equivalent; alternate years; offered 1973–74

29:131 Radio Astronomy 3 s.h.
Current developments in radio astronomy; radio-frequency radiations from sun, stars, planets and interstellar matter; observational techniques; prerequisite: 29:130; alternate years; offered 1973–74

29:137 Astronomical Laboratory 2 s.h.
Advanced laboratory work and observation with 24-inch telescope; techniques of astronomical photography, photometry and spectroscopy; laboratory work in data reduction, instrument calibration and numerical computation; prerequisites: 29:62 and consent of instructor; may be repeated

29:220 Individual Critical Study cr. arr.
See “Physics”

29:232 Theoretical Astrophysics I 3 s.h.
Theory of stellar photophysics and continuous spectra of stars; formation of absorption lines in spectra of stars; prerequisite: consent of instructor; alternate years; offered 1972–73

29:233 Theoretical Astrophysics II 3 s.h.
Interstellar matter, nebulae, novae and galactic radiation; continuation of 29:232, which is prerequisite; alternate years; offered 1972–73

29:234 Stellar Structure and Evolution 4 s.h.
Structure of stellar interiors; nuclear-generation and chemical synthesis in stars and evolution of stars; prerequisite: consent of instructor; alternate years; offered 1973–74

29:235 Special Topics in Planetary and Space Science 2 s.h.
One or more of following topics: solar interior, photosphere, chromosphere and corona; electromagnetic and corpuscular emissions of sun; interplanetary medium; internal structures, surfaces, atmospheres and electromagnetic properties of planets; asteroids and comets; may be repeated

29:263 Seminar: Astrophysics cr. arr.
Discussion of current research

29:282 Research in Astronomy cr. arr.
Prerequisite: consent of head of Department