101:106 Clinical Sciences 2 s.h.
Physical Therapy principles and procedures in relation to specific medical, surgical and orthopaedic conditions; significance of diagnostic tests and measurements for physical therapy procedures

101:110 Therapeutic Exercise I 4 s.h.
Principles and techniques of therapeutic exercise related to prevention, correction, alleviation of disease and injury; this semester includes posture, posture evaluation and exercises

101:111 Therapeutic Exercise II 4 s.h.
Continuation of 101:110, which is prerequisite; tests and measurements such as muscle testing, joint range of motion, gait analysis and functional activities

101:112 Therapeutic Exercise III 3 s.h.
Lectures, demonstrations, case presentations in principles and techniques of therapeutic methods relative to muscle reeducation and neuromuscular facilitation

101:113 Physical Therapy and Community Health Problems 3 s.h.
Definitive role of other health professionals in community health care and problem solving aspects of physical therapy

101:115 Kinesiology 3 s.h.
Study of normal functional human anatomy through learner-centered lectures, educational media techniques, self study and electromyographic demonstrations

101:118 Clinical Education I 2 s.h.
Practice of physical therapy procedures in hospital physical therapy department under supervision of qualified physical therapists

101:119 Clinical Education II 3 s.h.
Continuation of 101:118, which is prerequisite

101:121 Administration 2 s.h.
Administration of physical therapy department; need for and utilization of space, equipment, communications, records; ethical conduct and duties in relationship with professional coworkers, patients and lay personnel

101:122 Emotional Aspects of Disability 2 s.h.
Designed to explore emotional problems related to physical disability and to present overview of psychopathology; prerequisite: 6 s.h. psychology

101:131 Physical Agents cr. arr.
Massage: first seven and one-half weeks; theory, physiological effects and techniques of scientific massage as it is used in all aspects of physical therapy discussed and applied; *hydrotherapy:* second seven and one-half weeks; physics of water reviewed; techniques of whirlpool, hot and cold applications, underwater exercises in relation to various physical disabilities practiced and discussed

101:141 Professional Orientation and Ethics cr. arr.
Lecture, panel discussion, demonstrations; field of physical therapy, allied health professions, professional ethics and responsibility of individual and profession to society

101:190 Electrotherapy 3 s.h.
Principles, methods, techniques of useful forms of electricity directed toward therapeutic use in physical therapy; current electromedical developments and methods thought to be valuable discussed; laboratory sessions scheduled to aid student in development of technique of application

101:213 Seminar: Physical Therapy cr. arr.
Basic anatomy, neurophysiology and muscle physiology briefly reviewed; basic concepts of mechanics applied to human and to current and prospective practice of physical therapy; special emphasis placed on gait

101:275 Evaluation of Selected Neurological Disorders cr. arr.
Covers reflex testing methods for evaluating central nervous system development, as well as facilitation techniques used to obtain active automatic motor responses with progression toward more voluntary and purposeful movement

101:280 Practicum: Teaching Methods and Design 2 s.h.
Individual instruction, observation and experimentation in teaching, guidance and analysis of evaluation processes

101:290 Advanced Electrotherapy and Electrodiagnosis 2 s.h.
Study of electronic methods used for treatment and diagnosis of neuro-muscular disorders; special emphasis made on electromyography

101:301 Seminar: Thesis cr. arr.
Serves to guide and instruct students in all facets relating to thesis; formulation of problem, literature search, procedure for collecting data, analysis of data, organization of thesis and writing thesis

101:325 Independent Study cr. arr.
Problem-solving experience related to physical therapy; commensurate with student's interest and ability

101:326 Analysis of Scientific Literature cr. arr.
Seminar geared to develop student's ability to critically evaluate experimental research, knowledge in selected areas and verbal skills, plus ability to lead and interact within group situation

Physics and Astronomy

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

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	Introductory Physics I, II, III	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.

1972-1974

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.

22M:35–38	Engineering Mathematics I, II, III, IV	16 s.h.
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
  29:118 Kinetic Theory and Thermodynamics
  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:

29:117	Optics	3 s.h.
29:118	Kinetic Theory and Thermodynamics	3 s.h.
22M:130, 131	Elementary Theoretical Mechanics	6 s.h.
29:129, 130	Electricity and Magnetism	6 s.h.
29:133	Advanced Laboratory	4 s.h.
29:171, 172	Methods of Theoretical Physics	6 s.h.
29:191	Atomic Physics	3 s.h.
29:192	Nuclear Physics	3 s.h.
29:193	Introductory Solid State Physics	3 s.h.

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 specialized 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 less 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 receiving a grade of 500 or better in the Educational Testing Service foreign language examination *or* 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 emeriti* Tyndall, Wylie; *associate professors* Carpenter, Gurnett, Hershkowitz, Klink, Knorr, McCliment, Neff, Savage; *assistant professors* Fix, Joyce, Payne, Schlessinger, Schweitzer, Shawhan; *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-

ter hours, *or* 29:17, 18 Introductory Physics I and II, eight semester hours, *or* 29:61, 62 General Astronomy, eight semester hours, satisfy core requirement in natural science of College of Liberal Arts (q.v.)

Primarily for Undergraduates

29:1 College Physics **4 s.h.**
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

29:2 College Physics **4 s.h.**
Continuation of 29:1, which is prerequisite; electricity, magnetism, light and modern physics; both semesters and summer session

29:17 Introductory Physics I **4 s.h.**
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

29:18 Introductory Physics II **4 s.h.**
Electricity, magnetism and light; continuation of 29:17

29:19 Introductory Physics III **4 s.h.**
Atomic and nuclear physics and relativity; continuation of 29:18

29:82 Physics I **3 s.h.**
Unifying principles of classical and modern physics; mechanics, electricity, magnetism and wave phenomena; introduction to quantum mechanics; primarily for junior engineering students

29:83 Physics II **3 s.h.**
Continuation of 29:82; atomic and nuclear physics; other applications of fundamental concepts to modern physics; primarily for senior engineering students

29:93 Reading in Physics **cr. arr.**
Consult head of Department before registering

29:98 Undergraduate Seminar **1 s.h.**
Reading and discussion on selected topic in physics or astronomy under guidance of instructor; topic and instructor announced in advance of each semester; may be repeated

29:99 Honors Thesis **cr. arr.**
Supervised original research project leading to written report and oral defense; for junior and senior Honors candidates majoring in physics or astronomy

For Undergraduates and Graduates

29:103 Reading in Physics **cr. arr.**
Consult head of Department before registering

29:113 Physics of Sound and Music **3 s.h.**
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

29:117 Optics **3 s.h.**
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

29:118 Kinetic Theory and Thermodynamics **3 s.h.**
Kinetic theory of matter; macroscopic description of thermal phenomena; fundamental laws of thermodynamics and application

29:127 Electricity and Electrical Measurements **3 s.h.**
Electrical circuits, measurements and electronics, introduction to electromagnetic fields; two lectures and one laboratory each week; prerequisites: 29:2 or 29:18 and Mathematics 22M:26 or 22M:36

29:128 Electronics **3 s.h.**
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

29:129 Electricity and Magnetism **3 s.h.**
Electrostatics, magnetic fields, electromagnetic induction and introduction to Maxwell's equations; see 29:132 for laboratory work; prerequisite: Mathematics 22M:37 or equivalent

29:130 Electricity and Magnetism **3 s.h.**
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

29:132 Intermediate Laboratory **2 s.h.**
Laboratory work in electricity, magnetism and electronics; atomic, nuclear and solid state physics; optics; spectroscopy; one laboratory period each week; may be repeated

29:133 Advanced Laboratory **2 s.h.**
Laboratory work in optical spectroscopy, solid state, nuclear physics and cosmic rays; one laboratory period each week; may be repeated

29:149 Introductory Quantum Mechanics **3 s.h.**
Introductory course for majors in physics, astronomy, chemistry and other sciences

29:150 Cultural Issues in Physics **2 s.h.**
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

29:157 Physics for Artists **2 s.h.**
Discussion and laboratory course for nonscience students; study of properties of many different kinds of waves leading to understanding of holography; no prerequisites

29:158 Physics for Artists **2 s.h.**
Continuation of 29:157 which, however, is not prerequisite; study of many aspects of production and detection of color; no prerequisites

29:171 Methods of Theoretical Physics **3 s.h.**
Functions of complex variable, integration methods, linear vector spaces and matrix algebra; prerequisite: Mathematics 22M:28 or 22M:38

29:172 Methods of Theoretical Physics **3 s.h.**
Continuation of 29:171; Hilbert space, special functions, Fourier transform and expansions in orthogonal polynomials, differential equations and Green's functions

29:191 Atomic Physics **3 s.h.**
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

29:192 Nuclear Physics **3 s.h.**
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

29:193 Introductory Solid State Physics **3 s.h.**
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

29:194 Plasma Physics **3 s.h.**
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

29:195 Plasma Physics **3 s.h.**
Continuation of 29:194; linear and nonlinear solutions of the Vlasov equation, test charge problems and Fokker-Planck equation

Primarily for Graduates

29:205 Classical Mechanics **3 s.h.**
Dynamics of mass points; Lagrange's and Hamilton's equations; canonical transformations and Hamilton-Jacobi theory; prerequisite: Mathematics 22M:130

29:211 Mechanics of Continua **3 s.h.**
Hydrostatics, dynamics of ideal fluids, both incompressible and compressible; viscous flow; classical theory of elasticity; prerequisites: Mathematics 22M:130, 131, and 29:171, 172 or the equivalent

29:212 Statistical Mechanics I **3 s.h.**
Problem of Boltzmann; H-theorem and general principles of classical statistical mechanics; specific heat theory and nonideal gases; stochastic processes; Einstein-Bose and Fermi-Dirac statistics and applications; prerequisites: 29:118, Mathematics 22M:130, 131 and 29:171, 172 or the equivalent

29:213 Classical Electrodynamics **3 s.h.**
Advanced electromagnetostatics, boundary value problems, Green's functions, Maxwell's equations, radiation theory, physical optics and multipole expansion of radiation field; prerequisites: 29:129, 130, 171, 172 or equivalent

29:214 Classical Electrodynamics **3 s.h.**
Special relativity, motion of charges in fields, theories of radiation reaction and special topics; prerequisite: 29:213

29:220 Individual Critical Study **cr. arr.**
Essay written on topic chosen in consultation with faculty member; for candidates for M.S. degree without thesis in physics or astronomy

29:245 Quantum Mechanics I **3 s.h.**
Nonrelativistic 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 s.h.**
Continuation of 29:249

29:261 Seminar: Plasma Physics **cr. arr.**
Discussion of current research

29:262 Seminar: Solid State Physics **cr. arr.**
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, 245, 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.**
Phenomena in solar atmosphere; corpuscular and electromagnetic radiation in interplanetary space; geomagnetic field and interplanetary magnetic fields; magnetic storms; aurorae 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; Liouville equation; BBGKY hierarchy; Fokker-Planck equation and relaxation processes; Balescu-Lenard 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

29:94 Reading in Astronomy **cr. arr.**
Consult head of Department before registering

29:98 Undergraduate Seminar **1 s.h.**
See "Physics"

29:99 Honors Thesis **cr. arr.**
See "Physics"

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

29:119 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 photospheres 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-genesis 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