

FOR FURTHER INFORMATION

INFORMATION FOR PROSPECTIVE STUDENTS. This small booklet gives condensed general information concerning University colleges, schools, and other units. Also included: information on admission, fees, scholarships, student aid, housing, and student personnel services.

DESCRIPTIVE BOOKLETS. These booklets are available in the following fields: Botany, Business Administration, Dental Hygiene, Engineering, Engineering-Liberal Arts, Financial Aids, Fine Arts, Home Economics, Hospital Administration, Humanities, Journalism, Languages, Liberal Arts, Medical Technology, Mortuary Science (pre-), Museum Training, Nursing, Pharmacy, Physical Therapy, Physical Education (Men), Physical Education (Women), Sciences, Social Work, Speech, Dramatic Arts and Television, and "Your Home at SUI".

CATALOGUE SECTION REPRINTS. Sections of the General University Catalogue (similar to this booklet) pertaining to the following areas of study are available in reprint form: Colleges—Business Administration, Dentistry, Education, Engineering, Graduate, Law, Liberal Arts, Medicine, Nursing, and Pharmacy. Schools and Departments—American Civilization, Art, Botany, Chemistry, Child Welfare, English, European Literature and Thought, Geography and Geology, History, Home Economics, Journalism, Languages, Mathematics, Music, Oriental Studies, Philosophy, Physical Education (Men), Physical Education (Women), Physics and Astronomy, Political Science, Psychology, Religion, Social Work, Sociology and Anthropology, Speech, Dramatic Art and Television, Speech Pathology and Audiology, Zoology, and Health Services.

TO OBTAIN INFORMATION on any of the above fields or application forms for admission, write to the Dean of Admissions, University Hall, State University of Iowa, Iowa City.

FOR INFORMATION about married student or dormitory housing and application forms, write to the Dormitory Assignment Office, University Hall, State University of Iowa, Iowa City. For information about off-campus housing, scholarships, loans, and student employment, write to the Office of Student Affairs, University Hall, State University of Iowa, Iowa City.



Physics and Astronomy

STATE UNIVERSITY OF IOWA
Iowa City, Iowa

CALENDAR

FIRST SEMESTER 1961-62

September 5, Tuesday—Last date for applications for admission or transfer
 September 15, Friday—Reporting date for new undergraduates who have not completed the Placement Tests, 1:00 p.m.
 September 17, Sunday—Orientation for all new undergraduates, 7:00 p.m.
 September 18, Monday—Beginning of registration
 September 21, Thursday—Opening of classes, 7:30 a.m. University Induction Ceremony, 9:25 a.m.
 October 20 and 21, Friday and Saturday—Homecoming, classes suspended Friday 12:20 p.m.
 November 22, Wednesday—Beginning of Thanksgiving recess, 12:20 p.m.
 November 23, Thursday—University Holiday, offices closed.
 November 27, Monday—Resumption of classes, 7:30 a.m.
 December 15, Friday—Beginning of Holiday recess, 5:30 p.m.
 December 25 and 26, Monday and Tuesday—University Holiday, offices closed
 January 1, Monday—University Holiday, offices closed
 January 3, Wednesday—Resumption of classes, 7:30 a.m.
 January 26, Friday—Beginning of Examination Week 8:00 a.m.
 February 2, Friday—Close of First Semester classes, 5:30 p.m.
 February 3, Saturday—University Commencement, 10:00 a.m.

SECOND SEMESTER 1961-62

January 25, Thursday—Last date for applications for admission or transfer
 February 5, Monday—Beginning of registration, 8:00 a.m.
 February 7, Wednesday—Opening of classes, 7:30 a.m.
 February 25, Sunday—Foundation Day
 April 19, Thursday—Beginning of Easter recess, 12:20 p.m.
 April 24, Tuesday—Resumption of classes, 7:30 a.m.
 May 29, Tuesday—Beginning of Examination Week, 8:00 a.m.
 May 30, Wednesday—University Holiday, offices closed
 June 6, Wednesday—Close of Second Semester classes, 5:30 p.m.
 June 8, Friday—University Commencement, 9:30 a.m.
 June 9, Saturday—Alumni Day

SUMMER SESSION 1962

June 1, Friday—Last date for applications for admission or transfer
 June 11, Monday—Orientation for new undergraduate students
 June 12, Tuesday—Registration for 8-week session, 9:00 a.m.
 June 13, Wednesday—Opening of classes, 7:00 a.m.
 July 4, Wednesday—University Holiday, offices closed
 August 8, Wednesday—Close of Summer Session classes, 5:00 p.m. University Commencement, 7:30 p.m.
 August 9, Thursday—Opening of Independent Study Unit for Law and Graduate students
 September 3, Monday—University Holiday, offices closed
 September 5, Wednesday—Close of Independent Study Unit

FIRST SEMESTER 1962-63

September 4, Tuesday—Last date for applications for admission or transfer
 September 14, Friday—Reporting date for new undergraduates who have not completed the Placement Tests, 1:00 p.m.
 September 16, Sunday—Orientation for all new undergraduates, 7:00 p.m.
 September 17, Monday—Beginning of registration
 September 20, Thursday—Opening of classes, 7:30 a.m. University Induction Ceremony, 9:25 a.m.
 October 26 and 27, Friday and Saturday—Homecoming, classes suspended Friday 12:20 p.m.
 November 21, Wednesday—Beginning of Thanksgiving recess, 12:20 p.m.
 November 22, Thursday—University Holiday, offices closed
 November 26, Monday—Resumption of classes, 7:30 a.m.
 December 14, Friday—Beginning of Holiday recess, 5:30 p.m.
 December 24 and 25, Monday and Tuesday—University Holiday, offices closed
 January 1, Tuesday—University Holiday, offices closed
 January 3, Thursday—Resumption of classes, 7:30 a.m.
 January 25, Friday—Beginning of Examination Week, 8:00 a.m.
 February 1, Friday—Close of First Semester classes, 5:30 p.m.
 February 2, Saturday—University Commencement, 10:00 a.m.

PHYSICS

AND ASTRONOMY

Head of Department, James A. Van Allen
 Office, 108 Physics Building

The Department of Physics and Astronomy aims to provide opportunity for comprehensive study of all basic aspects of these subjects and for individual scholarly work at an advanced level.

Career Opportunities

Persons possessing a mastery of physics and astronomy are in great demand as teachers in universities and colleges and as research workers in government and industrial laboratories. Those with a good working knowledge of these subjects at the B.A. level find many opportunities in high school teaching and in a variety of administrative and technical pursuits.

Undergraduate Major in Physics

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

29:7, 8	General Physics	10 s.h.
29:9	Introduction to Modern Physics	3 s.h.
22:4, 5, 6, 7	College Algebra and Trigonometry, Analytic Geometry and Calculus	16 s.h.
22:103	Elementary Theoretical Mechanics	3 s.h.
29:129, 130	Electricity and Magnetism	8 s.h.
4:1 or 4:3	General Chemistry	4 s.h.

and 6 additional semester hours of physics and mathematics chosen from the following:

22:104	Elementary Theoretical Mechanics	3 s.h.
22:105	Advanced Calculus	3 s.h.
22:111, 112	Introduction to Analysis I, II	6 s.h.
29:117	Optics	4 s.h.
29:118	Heat and Thermodynamics	3 s.h.
29:133, 134	Atomic and Nuclear Physics Laboratory	4 s.h.
29:205	Classical Mechanics	3 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.

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

1. to take 29:171, 172, Methods of Theoretical Physics, during their junior or senior year,

2. to acquire reading facility in either Russian or German, and
3. to go beyond the minimum requirements listed above to the greatest feasible extent.

The elementary physics offerings are now arranged with 29:7, 8 as the appropriate selection for Honors candidates. Selected junior and senior majors take up to 8 semester hours of Honors Seminar 29:99 as part of their program for the degree Bachelor of Arts with Honors.

For the general requirements of the College of Liberal Arts, see *College of Liberal Arts*.

Undergraduate Major in Astronomy

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

29:7, 8	General Physics	10 s.h.
29:9	Introduction to Modern Physics	3 s.h.
29:61, 62	General Astronomy	8 s.h.
22:4, 5, 6, 7	College Algebra and Trigonometry, Analytic Geometry and Calculus	16 s.h.
22:103	Elementary Theoretical Mechanics	3 s.h.
29:119	Practical Astronomy	3 s.h.
29:120	Introduction to Astrophysics	3 s.h.
29:137	Astronomical Laboratory	2 s.h.

and 6 additional semester hours in astronomy, physics, and mathematics chosen from the following:

22:104	Elementary Theoretical Mechanics	3 s.h.
22:105	Advanced Calculus	3 s.h.
29:117	Optics	4 s.h.
29:118	Heat and Thermodynamics	3 s.h.
29:129, 130	Electricity and Magnetism	8 s.h.
29:131	Radio Astronomy	3 s.h.
29:181	Mathematical Astronomy	2 s.h.
29:191	Atomic Physics	3 s.h.
29:192	Nuclear Physics	3 s.h.

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

1. to take 29:129, 130, Electricity and Magnetism, during their junior or senior year,
2. to acquire reading facility in either Russian or German, and
3. to go beyond the minimum requirements listed above to the greatest feasible extent.

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).

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

For the general requirements for admission to the Graduate College and for advanced degrees, see *Graduate College*.

Master of Science Degree in Physics

The Master of Science 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 by a faculty committee appointed by the Dean of the Graduate College.

The program for the M.S. degree with thesis requires at least 24 semester hours of graduate course work and a thesis based on an original experimental or theoretical investigation by the candidate.

The program for the M.S. degree without thesis comprises a somewhat broader program of study (total of 38 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 (for which a maximum of 4 semester hours of credit is allowed). 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 completed satisfactorily at least the following courses or their equivalents as an undergraduate or a graduate, either at this university or elsewhere:

22:101	Differential Equations	3 s.h.
29:117	Optics	4 s.h.
29:118	Heat and Thermodynamics	3 s.h.
22:103, 104	Elementary Theoretical Mechanics	6 s.h.
22:105	Advanced Calculus	3 s.h.
29:129, 130	Electricity and Magnetism	8 s.h.
29:133, 134	Atomic and Nuclear Physics Laboratory	4 s.h.
29:191	Atomic Physics	3 s.h.
29:192	Nuclear Physics	3 s.h.

His plan of study should provide for as much advanced work as his aptitude and previous preparation permit. If he expects to continue toward a Ph.D. degree, he should take 29:171, 172 during his first year of residency. Study of scientific Russian or German is recommended but is not required of M.S. candidates.

Master of Science Degree in Astronomy

The Master of Science degree is offered with thesis or without thesis. The general nature of the program of study for either degree is similar to that for the corresponding M.S. degree in physics (*q.v.*).

Specific departmental requirements for the M.S. degree in astronomy are—

The substantial equivalent of the undergraduate major program in astronomy listed in an earlier paragraph, and as many of the following courses as feasible:

22:115	Numerical Methods in Mathematics	3 s.h.
22:116	Numerical Solution of Differential Equations	3 s.h.
29:131	Radio Astronomy	3 s.h.
29:171, 172	Methods of Theoretical Physics	6 s.h.
29:181	Mathematical Astronomy	2 s.h.
29:191	Atomic Physics	3 s.h.
29:192	Nuclear Physics	3 s.h.
29:233	Advanced Astrophysics	3 s.h.
29:234	Stellar Structure and Stellar Evolution	3 s.h.
29:235	Solar Physics	2 s.h.
29:273	Relativity	3 s.h.
29:278	Solar-Terrestrial Physics	2 s.h.
29:290	Physics and Chemistry of the Upper Atmosphere	2 s.h.

An individual plan of study must be worked out by each candidate early in his graduate study.

Doctor of Philosophy Degree in Physics

The program of study for the Ph.D. degree with major in physics includes—

1. Thorough course work in both classical and modern theoretical physics for all candidates, whether their specialized research is to be in an experimental or a theoretical area.

2. Comprehensive examinations.

3. Participation in advanced seminars.

4. Successful conduct of a major original research in either experimental or theoretical physics and the preparation and defense of a written dissertation based on this work.

Emphasis is laid on the capabilities developed and the 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: Classical Mechanics 29:205; the classical theoretical physics sequence, 29:211, 29:212, 29:213, and 29:214; Quantum Mechanics 29:245, 246, and 247; Advanced Nuclear Physics 29:249, 250; and Relativity 29:273.

Advanced mathematics such as the theory of functions of a complex variable and vector and tensor analysis are used freely in these courses. An introduction to these fields is given in Methods of Theoretical Physics 29:171, 172. The selection of less advanced courses will depend on the adequacy of the student's preparation for graduate work; his choice of more advanced and specialized courses will depend on the direction in which his interests develop.

Before a candidate is admitted to the comprehensive examinations he must acquire and demonstrate to the appropriate foreign language department the ability to read papers on physics in German and in one of the following three other languages—Russian, French, and Italian.

Each candidate must present and defend an original proposition of a research or speculative nature as a part of his comprehensive examinations.

A candidate for the Ph.D. degree will not be recommended for the degree until he has written his dissertation in proper form for formal publication and has submitted it, with the approval of his 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. 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. A twelve and one-half inch Cassegrain-Newtonian telescope is located at an outlying site.

The greater part of the experimental research in the department is in low-energy nuclear physics, cosmic rays, atmospheric physics, space physics, and astrophysics.

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

Persons qualified for graduate study are invited to apply for fellowships and assistantships. Inquiries should be directed to the departmental office.

STAFF

Professors: Fritz Coester, Max Dresden, Fritz Rohrlch, James A. Van Allen.

Professors Emeriti: John A. Eldridge,* E. P. T. Tyndall,* Charles C. Wylie (Astronomy).

Visiting Professor: Scott E. Forbush.

Associate Professors: Stanley Bashkin, Richard Carlson, Edward B. Nelson, Satoshi Matsushima (Astronomy).

Visiting Associate Professor: John B. Gregory.

Assistant Professors: Francis T. Cole,* Edwin Norbeck, Brian J. O'Brien, Ernest C. Ray.

Research Assistant Professor: Carl E. Mellwain.

Instructor: Wayne Day

Full-Time Research Associates and Assistants: Mrs. Annabelle Hudmon, Dr. Peter Kahn, Mr. David M. Kaplan, Mr. Ratan Piplani, Mr. Guido Pizzella, Dr. D. Venkatesan, Mr. William A. Whelpley, Mrs. T. Louise Wombolt.

*On leave of absence 1960-61.

Graduate College Research Fellow: Mr. Robert E. Pugh.
National Science Foundation Fellows: Mr. John E. Bergeson, Mr. James T. Cushing, Mr. Louis A. Frank.
U.S. Steel Foundation Fellow: Mr. John W. Freeman.
Graduate Research and Teaching Assistants: Mr. Morris I. Bank, Mr. Edward Berkowitz, Mr. Philip Chang, Mr. Tsu-Teh Chou, Mr. Raymond H. Cyr, Mr. David L. Dittmer, Mr. John W. Edie, Mr. Louis A. Frank, Mr. Harvey E. Groskreutz, Mr. Richard A. Gross, Mr. Dale W. Heikkinen, Mr. Gary Hockey, Mr. Duane F. Ingram, Mr. James M. Kauzlarich, Mr. Curtis D. Laughlin, Mr. Harvey S. Leff, Mr. Joseph Lenguadoro, Mrs. Hsey-Er Lin, Mr. Wei Ching Lin, Mr. Thomas A. Loftus, Mr. Robert L. McGrath, Mr. William F. Parks, Mr. Paul E. Peterson, Mr. Jerome Redus, Mr. Herbert H. Sauer, Mr. Larry D. Schlenker, Mr. Wayne A. Seale, Mr. Donald E. Simanek, Mr. Donald E. Stilwell, Mr. Daniel J. Tambasco, Mr. James D. Thissel, Mr. Kai Wai Wong, Mr. William Wen Yeh, Mr. John R. Zink.

COURSE DESCRIPTIONS

Physics

Primarily for Undergraduates

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

Open to freshmen. For engineering, premedical, pre dental, and pharmacy students and for others interested in elementary physics. Descriptive lectures and laboratory and problem work in mechanics, heat, and sound. Prerequisite, at least one year of work each in high school algebra and geometry. Both semesters and summer session. Instructors: O'Brien, Norbeck.

29:2 *College Physics* 4 s.h.

Continuation of 29:1, which is prerequisite. Electricity, magnetism, and light. Both semesters and summer session. Instructor: Carlson.

29:7 *General Physics* 5 s.h.

Open to freshmen. For physics and astronomy majors, Honors students and others by permission of instructor. Three lectures and one four-hour laboratory each week on mechanics, wave motion, sound, and heat. Pre- or co-requisite at least Mathematics 22:4. First semester. Instructor: Ray.

29:8 *General Physics* 5 s.h.

Continuation of 29:7, which is prerequisite. Electricity, magnetism, and light. Second semester. Instructor: Ray.

29:9 *Introduction to Modern Physics* 3 s.h.
(formerly 29:3)

Electronic, atomic, and nuclear phenomena from an experimental and interpretative point of view. Prerequisite. 29:7, 8. Instructor: Norbeck.

29:93 *Reading in Physics* cr.arr.

Consult head of department before registering. Staff.

29:99 *Honors Seminar* cr.arr.

For juniors and senior Honors candidates majoring in physics and astronomy. Guidance in conducting original scholarly investigations. Staff.

For Undergraduates and Graduates

(These courses presuppose a working knowledge of differential and integral calculus and completion of 29:7, 8 or equivalent.)

29:103 *Reading in Physics* cr.arr.

Consult head of department before registering. Staff.

29:117 *Optics* 4 s.h.

Geometrical and physical optics. Lectures and laboratory exercises

on the properties of lenses and simple optical instruments, and on the phenomena of propagation of electromagnetic waves, interference, diffraction, and polarization. Three lectures and one laboratory each week.

29:118 *Heat and Thermodynamics* 3 s.h.

Macroscopic description of thermal phenomena. The fundamental laws of thermodynamics and their applications.

29:126 *Electrical Measurements* 3 s.h.

For electrical engineering students. Two lectures, one laboratory, and one report each week. Second semester. Instructor: O'Brien.

29:128 *Electronics* 3 s.h.

Characteristics of vacuum tubes and transistors. Design and study of analog and digital circuits. Prerequisite, 29:129. First semester. Instructor: McIlwain.

29:129 *Electricity and Magnetism* 4 s.h.

Fundamental principles, including the phenomenological foundations of Maxwell's equations and their applications. Three lectures and one laboratory each week. Instructor: Van Allen.

29:130 *Electricity and Magnetism* 4 s.h.

Continuation of 29:129, which is prerequisite. Three lectures and one laboratory each week. Instructor: Van Allen.

29:133 *Atomic and Nuclear Physics Laboratory* 2 s.h.

Advanced laboratory study of fundamental atomic constants, radioactivity, X-rays, optical spectroscopy, and cosmic rays. One laboratory period each week. Prerequisites, 29:9 and 29:129. First semester. Instructor: Nelson.

29:134 *Atomic and Nuclear Physics Laboratory* 2 s.h.

Second semester. 29:133 is not prerequisite. Instructor: Nelson.

29:135 *Atomic and Nuclear Physics for Engineers* 2 s.h.

Brief introduction to atomic structure and nuclear phenomena, primarily for students in engineering; open to others by permission. (See 29:9.) Second semester.

29:171 *Methods of Theoretical Physics* 3 s.h.

Vector and tensor analysis, linear algebra, theory of analytic functions of a complex variable, and other mathematical developments used in theoretical physics. Instructor: Coester.

29:172 *Methods of Theoretical Physics* 3 s.h.

Continuation of 29:171. Instructor: Coester.

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

Black body radiation, photoelectric effects, elementary quantum theory and wave mechanics, relativity, atomic and molecular spectra, atomic structure, X-rays, molecular and electronic properties of solids, and fundamental atomic constants. Prerequisite, 29:9. Instructor: Nelson.

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. Instructor: Nelson.

Primarily for Graduates

29:205 *Classical Mechanics* 3 s.h.

Dynamics of mass points. A brief review of Lagrange's and Hamilton's equations. Canonical transformations and Hamilton-Jacobi theory. Topological methods and instability theory after Poincaré and Liapounoff. Applications include various topics in celestial mechanics. Prerequisites, Mathematics 22:103, 104. Instructor: Ray.

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29:211 *Classical Theoretical Physics I,*

Mechanics of Continua 3 s.h.

Hydrostatics, dynamics of ideal fluids, both incompressible and compressible; viscous flow; the classical theory of elasticity. Prerequisites, Mathematics 22:103, 104 and 29:171, 172, or the equivalent. Given in 1961-62 and alternate years thereafter. Instructor: Coester.

29:212 *Classical Theoretical Physics II, Kinetic Theory and Statistical Mechanics* 3 s.h.

Elementary kinetic theory of ideal and non-ideal gases. General principles of classical and quantum statistical mechanics. Systems of identical particles. Applications. Prerequisites, 29:118, Mathematics 22:103, 104 and 29:171, 172, or the equivalent. Given in 1960-61 and alternate years thereafter. Instructor: Dresden.

29:213 *Classical Theoretical Physics III, Electromagnetic Theory* 3 s.h.

Basic principles of electrodynamics. Derivation of the phenomena from Maxwell's equations. Maxwell's theory for moving bodies. Prerequisites, 29:129, 130 and 29:171, 172, or the equivalent. Given in 1960-61 and alternate years thereafter. Instructor: Coester.

29:214 *Classical Theoretical Physics IV, Optics and Electron Theory* 3 s.h.

Geometrical and wave optics. Interference and polarization of light. Theory of diffraction. Crystal optics. Emission and absorption of radiation. Electron theory of optical properties. Prerequisites, 29:129, 130 and 29:171, 172, or equivalent. Given in 1961-62 and alternate years thereafter.

29:220 *Individual Critical Study* cr.arr.

An essay is to be written on a topic chosen in consultation with a member of the faculty. For candidates for the M.S. degree without thesis in physics or astronomy. Staff.

29:231 *Atomic and Molecular Spectroscopy* 3 s.h.

Theoretical and applied spectroscopy. Classification and interpretation of spectra. Prerequisites, 29:191, 192 and 29:245. Instructor: Rohrlich.

29:245, 246, 247 *Quantum Mechanics I, II, and III* 3, 3, 3 s.h.

A comprehensive sequence on non-relativistic and relativistic quantum mechanics. Schrödinger wave mechanics, operator procedures, many particle systems, second quantization, relativistic equations. Instructors: Coester, Dresden, Rohrlich.

29:249, 250 *Advanced Nuclear Physics* 3, 3 s.h.

The phenomena of nuclear physics and their interpretation. Prerequisites, 29:191, 192 and 29:245. Instructor: Carlson.

29:265 *Seminar: Theoretical Physics* cr.arr.

Discussion of current research. Staff.

29:267 *Seminar: Nuclear Physics* cr.arr.

Discussion of current research. Staff.

29:269 *Special Topics in Nuclear Physics* cr.arr.

Advanced lectures on one or more of the following topics: nuclear forces, two body problems, nuclear models, electromagnetic properties of nuclei, theory of nuclear reactions, γ -decay, β -decay. Prerequisites, 29:249, 250. Instructor: Coester.

29:272 *Theory of Solids* 3 s.h.

General systematization of solid state theory. Electrons in periodic force fields. The zone scheme, distinctions between conductors and insulators, the effective mass motion, Fermi statistics. Thermal and magnetic properties of metals. Conductivity calculations. Col-

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lective theories of electron interactions. Prerequisites, 29:245 and 29:212 or equivalent. Instructor: Dresden.

29:273 *Relativity* 3 s.h.

Relativistic formulation of mechanics and electrodynamics; Einstein's theory of gravitation. Instructor: Rohrllich.

29:274 *Quantum Statistical Mechanics* 3 s.h.

The ensembles in quantum theory. Quantum mechanical partition function. Density matrix techniques. Applications to equilibrium and non-equilibrium situations. Non-ideal Fermi-Dirac and Einstein-Bose systems. Superconductivity. Prerequisites, 29:245 and 29:212, or equivalent. Instructor: Dresden.

29:276 *Special Topics in Quantum Mechanics* cr.arr.
Staff.

29:277 *Elementary Particle Physics* cr.arr.

Primarily non-field theoretic discussion of the elementary particles, especially in strong and weak interactions. Particle processes and decay schemes. Conservation laws and symmetry properties. Prerequisites, 29:249, 250 and 29:245, 246 and 247, or equivalents. Instructor: Rohrllich.

29:278 *Solar-Terrestrial Physics* 2 s.h.

Phenomena in the solar atmosphere, corpuscular and electromagnetic radiation in interplanetary space, the geomagnetic field and interplanetary magnetic fields, magnetic storms, aurorae and the geomagnetically trapped radiations. Instructors: Van Allen, Ray.

29:281 *Research in Physics* cr.arr.

Prerequisite, consent of head of department. May be continued for an indefinite number of semesters and in the summer. Staff.

29:290 *Physics and Chemistry of the
Upper Atmosphere* 2 s.h.

Continuous and molecular physics of neutral and ionized gases. Absorption of solar radiation in ionizing and dissociative effects in relation to ionosphere, ozone layer, and chemical processes in upper atmosphere. The air glow and aurora. Tides and winds in ionosphere and electric currents associated with daily magnetic variations and magnetic storms. Instructor: Ray.

Astronomy

Primarily for Undergraduates

29:61 *General Astronomy* 4 s.h.

Open to freshmen. Descriptive lectures and laboratory work in elementary astronomy. Solar system, earth, time, telescope, moon, and planets. One laboratory per week for observation with the telescope and problem work. Prerequisite, Mathematics 22:3 or at least one year each of high school algebra and geometry. Instructor: Matsushima.

29:62 *General Astronomy* 4 s.h.

Continuation of 29:61. Stellar astronomy. Motions and physics of the stars; systems of stars; interstellar matter; galaxies. Instructor: Matsushima.

29:94 *Reading in Astronomy* cr.arr.

Consult head of department before registering. Staff.

29:99 *Honors Seminar* cr.arr.

(See under "Physics.")

For Undergraduates and Graduates

29:104 *Reading in Astronomy* cr.arr.

Consult head of department before registering. Staff.

29:119 *Practical Astronomy* 3 s.h.

Design and use of astronomical instruments. Visual observations chiefly with the sextant for determination of longitude and latitude. Computation of orbits. Prerequisites, 29:61, 62; 29:7, 8 and Mathematics 22:7, or equivalents. Instructor: Wylie.

29:120 *Introduction to Astrophysics* 3 s.h.

Basic problems and methods of astrophysics. Radiation and spectra of stars; stellar atmospheres; and solar phenomena. Prerequisites, 29:9 and Mathematics 22:7, or equivalents. Instructor: Matsushima.

29:131 *Radio Astronomy* 3 s.h.

Current developments in radio astronomy; radio-frequency radiations from the sun, stars, planets and interstellar matter. Observational techniques. Prerequisite, 29:120. Instructor: Van Allen.

29:137 *Astronomical Laboratory* 1 s.h.

Photographic and photoelectric observations with the 12-inch Newtonian-Cassegrain telescope. Laboratory work in spectro-photographic and spectro-photometric analysis. Computing work in orbit theory and eclipses. One laboratory period each week. Prerequisite, 29:120. Both semesters. May be repeated. Staff.

29:181 *Mathematical Astronomy* 2 s.h.

Elements of orbit theory and of celestial mechanics. Distributions and motions of stars and stellar systems. Stellar statistics and stellar dynamics. Prerequisites, 29:7, 8 and Mathematics 22:101 and 22:103. Staff.

29:220 *Individual Critical Study* cr.arr.

An essay is to be written on a topic chosen in consultation with a member of the faculty. For candidates for the M.S. degree without thesis in physics and astronomy. Staff.

29:233 *Advanced Astrophysics* 3 s.h.

Prerequisite, consent of instructor. Theory of stellar atmospheres, variable stars, peculiar stars, and interstellar matter.

29:234 *Stellar Structure and Stellar Evolution* 3 s.h.

Prerequisite, consent of instructor. Internal constitution of stars and white dwarfs. Nuclear astrophysics, evolution of stars, and chemical elements in the stars.

29:235 *Solar Physics* 2 s.h.

Prerequisite, consent of instructor. Theoretical and spectro-photometric interpretation of photospheric phenomena. Structure of chromosphere and corona. Optical and radio-frequency radiation from the sun in relation to geophysical disturbances.

29:282 *Research in Astronomy* cr.arr.

Prerequisite, consent of head of department. May be continued for an indefinite number of semesters and in the summer. Staff.