UNDERGRADUATE STUDIES

In

PHYSICS, ASTRONOMY, ASTROPHYSICS, ENGINEERING PHYSICS

The University of Oklahoma

August 2005

University of Oklahoma

Department of Physics and Astronomy

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PREFACE FROM THE CHAIR

Dear Student,

Undergraduate majors have always been an important and vital part of the Department of Physics and Astronomy. Together with our graduate students, staff, and faculty; you form a community of scholars who learn, practice, enhance, and enjoy physics and astronomy. We welcome you to the Department! We hope that this handbook helps to smooth your progress through your undergraduate studies.

As you make your way through our very fine sequence of formal courses, please also be sure to take advantage of the many opportunities to be involved in world-class research. You will find that research participation will make your physics and astronomy degree special!

Sincerely,

Ryan Doezema, Chair
Department of Physics and Astronomy

DEPARTMENT OF PHYSICS AND ASTRONOMY WEBSITE:

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ADVISING

Faculty Advisors

There are three faculty members in the Department who have primary responsibility for advising undergraduates. At the present time, they are **Dr. John Furneaux** – Physics, **Dr. Karen Leighly** – Astronomy and Astrophysics, and **Dr. Stewart Ryan** – Engineering Physics. Like all faculty, they hold regular office hours (posted in the Department office) and will gladly see you by appointment at other times. They are good sources of information and advice.

Registration

Twice a year it will be necessary for you to see an advisor before you register for courses for the next semester. You will get a letter (mailed to the address you have on file with the University) from the Department before registration begins reminding you of the procedures. Of course, you are always welcome to see an advisor at any time during the school year. You do not have to wait for a reminder.

University College

If you enter the University as a freshman, your first advisor will probably be a staff member, either from University College or from the OU Scholars or Honors Programs. You are a student in University College until you qualify for admission to one of the colleges that actually have academic departments and award degrees. University College merely enrolls and advises new students until they are ready to transfer to another college, usually at the end of their freshman year. **(Although your official advising is in the University College, we strongly recommend you stop by the department and meet with one of our advisors also. They will be able to answer questions you may have about our program in more depth than University College personnel will.)**

After you have met the necessary general requirements, described in detail in the University of Oklahoma General Catalog 2003 - 2005, majors in Physics, Astronomy and Astrophysics will transfer to the College of Arts and Sciences; majors in Engineering Physics to the College of Engineering. As with all University regulations, you should make it your business to know what they are. Once you have been transferred, all your advising will normally be done in the Department.

College Advisors

In addition to working with faculty advisors from the department, you will occasionally want to consult an Academic Counselor from your College, either Arts and Sciences or Engineering. The current physics and astronomy advisor for the College of Arts and Sciences is **LeQui Raymond**. Three advisors are available in the Koch Advising Center for the College of Engineering. These are professional staff members whose job it is to maintain your academic records and ultimately to verify that you have satisfied all the requirements for graduation (once you have reached Senior standing [90 credit hours] they will perform, at your request, a "degree-check" for you). They are also a good source of information on University regulations. Call your College office for an appointment.

Transfer Students

If you transfer to OU from another institution of higher learning and qualify for admission directly to a degree-granting college, you will enter that college instead of University College.

The Admissions Office, during the initial application process, routinely performs an evaluation of your previous coursework using the Computerized Transcript Evaluation System. Courses are evaluated in terms of OU equivalents. For courses without OU equivalents, you should schedule an appointment with one of the Academic Counselors in your College. They may be able to determine transfer credit for particular courses or they will refer you to the appropriate department advisor for a review of the course in question. It will be to your advantage to have course descriptions and syllabi for those courses that must be individually evaluated. Coursework in your major (i.e., physics and astronomy courses) will be evaluated by one of the faculty advisors in our Department. The faculty advisor will also help you select the courses at OU, which will best enable you to fit into one of our programs.

GETTING STARTED IN YOUR MAJOR

The courses required for our majors usually cannot be taken out of sequence; each builds upon the previous course. Moreover, the curriculum is quite full. It is prudent to start the major as early as possible, in order to graduate in a timely fashion. We strongly recommend that majors start taking physics courses in their freshman year, if at all possible.

Physics 1205-1215

Whatever your major emphasis within the Department (Physics, Astronomy, Astrophysics, or Engineering Physics), it is important that you take your first physics courses as soon as possible. Normally, this will be the two-semester sequence Physics 1205-1215 - Introductory Physics for Physics Majors, which is offered once a year beginning in the fall semester. Math 1823 - Calculus & Analytic Geometry I, is a co-requisite for Physics 1205. If you enter the University as a freshman, you will have to take a mathematics placement exam. You must test into Math 1823 or a higher math course in order to enroll in Physics 1205.

Physics 2514-2524

With permission from your advisor, it is also possible to start your physics courses with the two-semester sequence Physics 2514-2524 - General Physics for Engineering and Science Majors. This is a large lecture course taken mainly by engineering students. Since it has no laboratory, you will be required to take two additional hours of physics lab (such as Phys 3302 – Advanced Lab I, Advanced Lab II) or an equivalent before you graduate. Math 1823 – Calculus and Analytical Geometry I is a prerequisite (not a co-requisite) for Physics 2514. Since these courses place more emphasis on practical applications and less on fundamentals, you will get a better start on your major by taking Physics 1205-1215. On the other hand, if for some reason you have already taken Physics 2514-2524 or its equivalent, there is no need to repeat the material. Move ahead to the next level.

Physics 2414-2424

If you have taken these courses you should talk to the Undergraduate Studies chair to make a recommendation for how to proceed.

CHOOSING YOUR PROGRAM

Major Courses

Whether you choose to major in Physics, Astronomy, Astrophysics, or Engineering Physics your required courses in physics and mathematics will be very similar. In the first two years, they are nearly identical. Over four years, Physics majors take a few more courses in physics and mathematics; Astronomy/Astrophysics majors take astrophysics courses instead; and Engineering Physics majors take, in addition to the physics and math courses, all the engineering courses required for a professional engineering degree. The exact requirements for each degree are given in the pages that follow.

General Education

In addition to the degree requirements specified by the Department, the University requires that all students, whatever their major, take a certain number of courses in general education (e.g. English composition, history, foreign language). These course requirements total about 40 hours, and need to be part of your curriculum planning. A curriculum guideline for each major detailing these general educational requirements is included in this handbook. Consult the University catalog and talk to your advisor for additional details.

Common Degree Requirements

〈 Mathematics - *The Language of Physics*

You will notice that mathematics is an integral part of the curriculum for all our degree programs from the very beginning. The reason for this is fundamental: mathematics is the language of physics. By this, we do not mean simply that physicists use mathematics to communicate with each other, although they do. We mean that the basic ideas of physics are themselves mathematical. Especially in modern physics, where human intuition often fails, the ideas of physics are inseparable from their mathematical expression. Furthermore, a goal of physics is to make quantitative predictions about the world we live in – predictions subject to observation and measurement. Quantitative predictions require mathematics. The integration of mathematics and physics can be difficult but is absolutely necessary for success in physics.

〈 Laboratory

Another important part of the Physics curriculum is laboratory work. Some of the laboratory work will help you to clarify physics concepts and some will introduce you to experimental techniques and instruments. If you should choose someday to work or teach in experimental physics, your laboratory training will help you directly. However, even if you do not, it is important for every physicist to understand the relationship between physics theory and experimental

evidence, and to appreciate what constitutes a good experiment. Laboratory work is difficult and time-consuming, but essential to your education.

〈 Senior Research Project - The Capstone Experience

All Departmental major seniors - Physics, Astronomy, Astrophysics and Engineering Physics - are required to enroll in four hours of Physics 4300 - Senior Research Project. (Every major in the College of Arts and Sciences is required to do a senior research project.) All majors in their senior year are to complete a research project leading to a written thesis (with possible exceptions described below). Each project is under the direction of an individual faculty member, and will extend through two semesters.

Enrollment for this course begins with a visit to the Physics Office for a green departmental enrollment card. The completed card, returned to the Undergraduate Studies Secretary, is exchanged for a pink “Authorization To Enroll” slip and a course syllabus.

For students in Arts and Sciences, projects can be experimental or theoretical; engineering physics student **MUST** do a project that involves engineering design. Successful projects will take the academic year to complete, so students will enroll in PHYS 4300 during two semesters of a total of four credit hours, preferably two hours each semester. The courses consist of a research project, experimental or theoretical, performed under the direction of an individual faculty member. This course will satisfy the requirement of the University that all undergraduates participate in a "Capstone Experience" in their major. It will be your responsibility to make arrangements with a faculty member for your project.

Each project will culminate in a substantial written product, in the nature of a senior thesis. The thesis will be written so as to be intelligible to other senior physics and astronomy majors not familiar with the research topic. In addition, each student will present an oral report on the project to a seminar consisting of all students enrolled in the course. The seminar will meet as necessary to hear and discuss the reports, and at the discretion of the supervisor to discuss topics of current interest in physics and astronomy.

CAS students who desire and can profit from an interdisciplinary Capstone experience: Students may petition our Undergraduate Studies Committee to replace up to three hours of Physics 4300 with an equal number of hours of an advanced course (3000 level or higher) in a complementary scientific discipline which integrates topics from the student's major in a significant way. Approved courses include, but are not limited to, those listed below. One hour of Physics 4300 would still be required, incorporating participation in the seminar, an oral report, and a term paper of at least 25 pages drawing on the material of the complementary course. Partial List of Approved Courses:

AME	4593	Space Science and Systems
E E	5343	Opto-Electronics
GEOL	5713	Solid Earth Geophysics

Other courses may also be approved. In general, an appropriate course should have prerequisites, which are substantial but not prohibitive to a non-major; it should be sufficiently advanced to prepare a student to write a major term paper; and it should incorporate concepts from physics or astronomy

〈 Take Your Time

One final admonition: TAKE YOUR TIME. Learning in physics cannot be rushed, nor can it be forced. Memorization will not do. Basic understanding to make intellectual connections is required. You must develop a whole new language and learn many new skills. Physics, in particular, takes time to learn because it is hierarchical. Courses are taught in sequence, and topics taught in one course depend on knowledge from another. You will notice that the Department requires a grade of "C" or better in each required course in physics, astronomy, and mathematics. The reason for this is that without at least a "C" in one course, you will not be prepared to succeed in the next course in the sequence. Furthermore, if you want to go to graduate school, you will need at least a "B" average in upper division undergraduate work. It is better to slow down and postpone a course, if necessary, than to get a poor grade. Be sure to talk with your teacher and advisor if you begin to fall behind in a course.

IF YOU CHOOSE PHYSICS

Degree Programs

There are two different degree programs in Physics: the professional degree of **Bachelor of Science in Physics** (major code-1902B), and the standard degree of **Bachelor of Science** (major code-1902A). Students planning to continue into graduate study, or who, for any reason, want a comprehensive curriculum, are advised to take the professional degree program. This program can be completed in four years, although some students take five years. Students who want a less comprehensive program may choose the standard degree, which takes less time. It is possible, although we strongly discourage it, to enter graduate school with the standard degree and take the missing courses as a graduate student.

Course Requirements

Look over the curriculum guidelines for the two degrees in Physics at the end of this section. They represent carefully designed programs with a definite logical structure. *Courses need to be taken in the sequence shown because each course builds on previous courses.* You will be handicapped if you take them out of order. Except for the four courses in Calculus and Analytic Geometry, the course in Chemistry, Advanced Lab and Capstone. All the courses listed are offered only once a year during the fall or spring semester. Therefore, it is important for you to plan carefully. Special circumstances, especially for transfer students, may occasionally warrant some changes in sequence. This is where advice from the Physics and Astronomy faculty is absolutely necessary. Please, do not modify these programs without your faculty advisor's consent.

Mathematics - Upper Division

For the professional Physics degree, mathematics is required through Math 3423 - Physical Mathematics II, and an upper division elective. Good choices for the elective are Math 3333 - Linear Algebra, Math 4103 - Introduction to Functions of a Complex Variable, Math 4653 - Introduction to Differential Geometry, and Math 4073 - Numerical Analysis. In fact, as with physics electives, you will be better prepared for graduate school if you take more math courses than are required.

Optional Courses

You will notice that a few courses on the curriculum guideline for the professional program are recommended but not required for the degree. If you plan to attend graduate school or perform professional work in physics, you are strongly recommended to take these additional classes. Material from these courses is included in the written qualifying exam required for graduate students in our Department.

CURRICULUM GUIDELINES for STANDARD PHYSICS DEGREE

Degree Code 1902A 2004-2005

Semester I (Fall)

PHYS 1205 Phys I for Majors
MATH 1823 Calculus & Analytic Geometry I

Semester II (Spring)

PHYS 1215 Phys II for Majors
MATH 2423 Calculus & Analytic Geometry II
CHEM 1315 General Chemistry
(Only required for those without 1 year of high school chemistry)

Semester III

PHYS 2203 Phys III for Majors: Modern Phy
PHYS 2303 Electronics
MATH 2433 Calculus & Analytic Geometry III

Semester IV

PHYS 3043 Physical Mechanics I
MATH 2443 Calculus & Analytic Geometry IV
MATH 3413 Physical Math I

Semester V

PHYS 3053 Physical Mechanics II
PHYS 3183 Elec & Magnetism I

Semester VI

PHYS 3302 Advanced Laboratory I
PHYS 3803 Quantum Mechanics I

Semester VII

PHYS 4300 Senior Lab Project (Capstone)
PHYS 30000(Physics Elective)

Semester VIII

PHYS 4300 Senior Lab Project (Capstone)

Required Hours:	Physics	37	
	Math	15	
	Chem	5	Or 1 year High School Chemistry
	Gen Ed	40	
	Free Electives	27	32 if no Chemistry
		124	

A grade of 'C' or better must be earned in each required Physics and Math course.

CURRICULUM GUIDELINES for PROFESSIONAL PHYSICS DEGREE

Degree Code 1902B 2004-2005

Semester I (Fall)

PHYS 1205 Phys I for Majors
MATH 1823 Calculus & Analytic Geometry I

Semester II (Spring)

PHYS 1215 Phys II for Majors
MATH 2423 Calculus & Analytic Geometry II
CHEM 1315 General Chemistry
(only required for those without 1 year of high school chemistry)

Semester III

PHYS 2203 Phys III for majors: Modern Phys
PHYS 2303 Electronics
MATH 2433 Calculus & Analytic Geometry III

Semester IV

PHYS 3043 Physical Mechanics I
MATH 2443 Calculus & Analytic Geometry IV
MATH 3413 Physical Math I

Semester V

PHYS 3053 Physical Mechanics II
PHYS 3183 Elec & Magnetism I
MATH 3423 Physical Math II

Semester VI

PHYS 3302 Advanced Lab I
PHYS 3803 Quantum Mechanics I
*Physics/Math Elective

Semester VII

PHYS 3312 Advanced Lab II
PHYS 4153 Stat Phys-Thermodyn
PHYS 4300 Senior Lab Project (Capstone)
*Physics/Math Elective

Semester VIII

PHYS 4300 Senior Lab Project (Capstone)
*Physics/Math Elective

<u>*Physics/Math Electives</u>

Choose two of the following: 4213 Nuclear Particle Physics, 4243 Solid State Physics, 4813 Atomic Molecular Physics, 4183 Electricity & Magnestism II, 4803 Quatum Mechanics II

Plus 3 upper division hours of math electives.

Required Hours:	Physics	45	(Includes 6 elective hours)
	Math	21	
	Chem	5	or 1 year of High School chemistry
	Gen Ed	40	
	Free Electives	<u>13</u>	18 if no chemistry
		124	

A grade of 'C' or better must be earned in each required Physics and Math course.

IF YOU CHOOSE ASTRONOMY OR ASTROPHYSICS

Degree Programs

There are two different degree programs in Astronomy/Astrophysics: one is the professional degree called **Bachelor of Science in Astrophysics** (major codes-1912A), and the other is the standard degree in Astronomy called **Bachelor of Science** (major codes-1911A). Students who intend to go to graduate school and become professional astronomers will need the professional degree in Astrophysics. The enormous scientific developments in this century have brought astronomy closer to physics. Now, it is no longer limited to a field of research, but it can be considered a branch of physics. It is the application of physics to astronomical phenomena. The standard degree comprises a rigorous introduction to astronomy for students who plan other pursuits after graduation. Both programs include a substantial number of courses in mathematics and physics as well as astronomy. Curriculum guidelines for both degrees are at the end of this section.

Course Requirements

Many of the comments from the section, "CHOOSING YOUR PROGRAM" and "IF YOU CHOOSE PHYSICS," pertain to Astrophysics and Astronomy as well. The courses are hierarchical; each course depends on its predecessors. The program cannot be rushed. The courses are offered only once a year, in the semester indicated on the course listings. Mathematics is important, as is laboratory work. In this case, laboratory work includes Astronomy 2513 - Observatory Methods.

Optional Courses

Some Astronomy courses are offered but not required. Astronomy 1504 - General Astronomy (not listed), is a descriptive introduction to Astronomy that fulfills a general education requirement. It cannot be used for major credit. The backbone of the curriculum for both degrees is the required sequence Astr 3103- Stars, and Astr 3113 – Galaxies & Cosmology. These courses offer an overview of the universe from the solar system to extragalactic astronomy, using calculus and basic physics. They may be taken in the sophomore year if the prerequisites are fulfilled. Astr 4303 - Stellar Astrophysics (the study of stellar interiors and stellar evolution) is required of Astrophysics majors but not Astronomy majors. Astr 2513 - Observatory Methods, is required for both majors. For both degrees, your undergraduate studies will conclude with four hours of Phys 4300 - Senior Research Project. This will be a project, theoretical or observational, arranged with one of the Astronomy faculty, to satisfy the general education requirement for the "Capstone Experience" in your major (page 11).

Electives

An additional 3-credit hour elective is required for Astrophysics majors. It may be one of following: Physical Math II, Electricity & Magnestism II, Quatum Mechanics II, or a graduate ASTR class. We strongly recommend that Astrophysics majors take additional electives from this list.

CURRICULUM GUIDELINES for ASTRONOMY DEGREE

Degree Code 1911A 2004-2005

Semester I (Fall)

PHYS 1205 Phys I for Majors
MATH 1823 Calculus & Analytic Geometry I

Semester II (Spring)

PHYS 1215 Phys II for Majors
MATH 2423 Calculus & Analytic Geometry II
CHEM 1315 General Chemistry

Semester III

PHYS 2203 Phys III for Majors: Modern Phys
MATH 2433 Calculus & Analytic Geometry III
ASTR 2513 Observatory Methods

Semester IV

MATH 2443 Calculus & Analytic Geometry IV
MATH 3413 Physical Math I
PHYS 3043 Physical Mechanics I

Semester V

ASTR 3103 Stars
PHYS 3053 Physical Mechanics II

Semester VI

ASTR 3113 Galaxies & Cosmology
Physics/History of Science Elective

Semester VII

PHYS 4300 Senior Lab Project (Capstone)
Physics/History of Science Elective

Semester VIII

PHYS 4300 Senior Lab Project (Capstone)

Required Hours:	Physics	23
	Astronomy	9
	Math	15
	Chem	5
	Gen Ed	40
	Physics/HSCI Elective	3
	Free Electives	29
		124

A grade of 'C' or better must be earned in each required Physics and Math course.

CURRICULUM GUIDELINES for ASTROPHYSICS DEGREE

Degree Code 1912A 2004-2005

Semester I (Fall)

PHYS 1205 Phys I for Majors
MATH 1823 Calculus & Analytic Geometry I

Semester II (Spring)

PHYS 1215 Phys II for Majors
MATH 2423 Calculus & Analytic Geometry II

Semester III

ASTR 2513 Observatory Methods
PHYS 2203 Phys III for Majors: Modern Phys
MATH 2433 Calculus & Analytic Geometry III

Semester IV

PHYS 3043 Physical Mechanics I
MATH 3413 Physical Math I
MATH 2443 Calculus & Analytic Geometry IV

Semester V

PHYS 3053 Physical Mechanics II
PHYS 3183 Elec & Magnetism I
ASTR 3103 Stars

Semester VI

PHYS 3803 Quantum Mechanics I
PHYS 3302 Advanced Lab I
ASTR 3113 Galaxies & Cosmology

Semester VII

ASTR 4303 Stellar Astrophys
PHYS 4300 Senior Lab Project (Capstone)
PHYS 4153 Stat Phys-Thermodyn

Semester VIII

PHYS 4300 Senior Lab Project (Capstone)
Astro/Physics/Math Elective

Elective
Choose one of the following: Math 3243 Physical Math II, Phys 4183 Electricity & Magnestism II, Phys 4803 Quantum Mechanics II or graduate ASTR class.

Required Hours:	Physics	37
	Astronomy	12
	Math	15
	Gen Ed	40
	Phys/Astro/Math	3
	Free Electives	15
		124

A grade of 'C' or better must be earned in each required Physics and Math course.

IF YOU CHOOSE ENGINEERING PHYSICS

Degree Program

Engineering Physics (major codes-0919A) provides an interdisciplinary environment where pure and applied science merges. The program is designed to develop sufficient depth in both engineering skills and physics to produce engineers who are able to relate basic knowledge to practical problems in engineering. The objectives of the program (detailed at www.nhn.ou.edu/ephys) are to provide: 1) an in-depth understanding of physics, 2) a fundamental knowledge of the engineering applications of modern physics, and 3) communication and teamwork skills, and experience in instrumentation and other areas important for practicing engineers. The goal of these objectives is to enable graduates to pursue and contribute to new fields as they emerge.

Accreditation Board for Engineering and Technology (ABET)

The Engineering Physics curriculum is accredited by ABET, the Accreditation Board for Engineering and Technology. The curriculum includes the basic core of courses in science, mathematics, and engineering common to all engineering curricula: a block of upper division physics courses, and a planned sequence of advance courses in engineering and physics that fulfills the design/synthesis requirement of ABET. The physics and mathematics courses required are virtually the same as those required for the Professional Physics degree. The result is a very full curriculum, with very little time (within a "standard" four-year time frame) for electives in other academic fields. Of course, all students in the University must satisfy the general education requirements. Details of the curriculum are with the course listing for Engineering Physics on the next page. Your faculty advisor must approve all electives you choose. The five "engineering electives" (15 hours) taken in the junior and senior years are known as the "design sequence" and must be in one of the traditional engineering disciples (e.g., electrical or mechanical engineering). The courses for this design sequence must be at the 3000 or above level and are set by an engineering advisor in that engineering disciple, subject to the approval of the engineering physics advisor. To meet ABET requirements, the 15 hour design sequence must contain at least 8 hours of engineering design (less any design hours taken in the technical electives or the engineering physics electives).

Capstone Project

Engineering physics students must do a capstone project (Phys 4300) that emphasizes engineering design. See page 11 for details.

IF YOU CHOOSE A PHYSICS, ASTROPHYSICS OR ENGINEERING PHYSICS

HONORS COLLEGE PROGRAM

The Honors College at the University of Oklahoma is dedicated to providing academically gifted students with the opportunity to develop their intellectual potential to the fullest. By maintaining a high GPA and participating in honors-designated courses/sections, as well as special seminars and workshops, students can earn degree designations of *cum laude*, *magna cum laude*, or *summa cum laude*.

Honors-designated general education courses within the department include Phys 1205 and 1215 – Physics for Majors, and Phys 2514 and 2524 – General Physics for Engineers. Upper division courses include Phys 3960 – Individual Honors Reading, and Phys 3980 – Individual Honors Research.

Full details about the Honors College and honors curriculum may be obtained from the Honors College office, located in the honors residence hall in the Cate Complex. For specific questions about honors in physics, astrophysics and engineering physics, talk with Dr. Sheena Murphy, our department's Honors College faculty advisor, in Nielsen Hall – room 101.

IF YOU CHOOSE A PHYSICS OR ASTRONOMY MINOR

You can earn a "minor" in Physics or Astronomy from the College of Arts and Sciences by completing the course requirements (25-32 credit hours) given in the course listings. The Advising Office for the College of Arts and Sciences has a “Request for Area of Concentration, Minor, or Second Major” form that you will need to complete to officially declare your minor.

A minor can be a valuable adjunct to such majors as mathematics, meteorology, philosophy, or literature. Sample curriculum guidelines and worksheets follow.

NOTE: Astronomy, astrophysics, majors cannot earn a double major or a minor in physics nor vice versa. The College of Engineering does not offer minors and Engineering Physics majors cannot earn a double major or minor in physics.

PHYSICS MINOR

2003-2004

PHYSICS 1205 SAMPLE CURRICULUM

Semester I (Fall)			Semester II (Spring)		
PHYS	1205	Physics I for Physics Majors	PHYS	1215	Physics II for Phys Majors
MATH	1823	Calculus & Analytic Geometry I	MATH	2423	Calc & Analytic Geometry II
Semester III			**Semester IV**		
PHYS	2203	Phys III for Majors: Modern Physics	PHYS	3043	Physical Mechanics I
MATH	2433	Calculus & Analytic Geometry III	MATH	3413	Physical Math I
Semester V			**Semester VI**		
(PHYS	3053)	Physical Mechanics II	(PHYS	3803)	Intro to Quantum Mech I
(PHYS	3183)	Electricity & Magnetism I			

Minimum Required Hours: Physics 19
Mathematics 12
31

PHYSICS 2514 SAMPLE CURRICULUM

Semester I (Fall)			Semester II (Spring)		
MATH	2423	Calculus & Analytic Geometry II	[PHYS	1321]	General Physics Lab II
[PHYS	1311]	General Physics Lab I	PHYS	2524	General Physics for Engrs
PHYS	2514	General Physics for Engineers	MATH	2433	Calc & Analytic Geometry III
Semester III			**Semester IV**		
PHYS	2203	Intro Phys III: Modern Physics	PHYS	3043	Physical Mechanics I
[PHYS	2303]	Electronics	MATH	3413	Physical Math I
Semester V			**Semester VI**		
(PHYS	3053)	Physical Mechanics II	(PHYS	3803)	Intro to Quantum Mech I
(PHYS	3183)	Electricity & Magnetism I			
[PHYS	3302]	Junior Lab I			

Minimum Required Hours: Physics 19
Mathematics 12
31

( ) Indicates the course is optional; however, at least ONE of the courses listed is required.
[ ] Indicates the course is optional; however, 2 credit hours of lab is required.
* This course is a pre-requisite for Math 3413.

Minimum Required Hours are higher than indicated on the College of Arts & Sciences form (page 32) because pre-requisite math courses are included

ASTRONOMY MINOR

2003-2004

PHYSICS 1205 SAMPLE CURRICULUM

Semester I (Fall)			Semester II (Spring)		
PHYS	1205	Physics I for Physics Majors	PHYS	1215	Phys II for Physics Majors
*MATH	1823	Calculus & Analytic Geometry I	*MATH	2423	Calculus & Analytic Geometry II
Semester III			**Semester IV**		
PHYS	2203	Phys III for Majors: Modern Physics	PHYS	3043	Physical Mechanics II
ASTR	2513	Observatory Methods	MATH	2443	Calculus & Analytic Geometry IV
MATH	2433	Calculus & Analytic Geometry III			
Semester V			**Semester VI**		
ASTR	3103	Stars	ASTR	3113	Galaxies & Cosmology

* (Courses are pre or co requisites)

Required Hours:		
	Physics	16
	Astronomy	9
	Mathematics	3
		28

PHYSICS 2514 SAMPLE CURRICULUM

Semester I (Fall)			Semester II (Spring)		
MATH	1823	Calculus & Analytic Geometry I	MATH	2423	Calc & Analytic Geometry II
Semester III			**Semester IV**		
PHYS	2514	General Physics for Engrs	PHYS	2524	General Physics for Engrs
MATH	2433	Calculus & Analytic Geometry III	MATH	2443	Calculus & Analytic Geometry IV
Semester V			**Semester VI**		
PHYS	2203	Phys III for Majors: Modern Physics	PHYS	3043	Physical Mechanics II
ASTR	2513	Observatory Methods			
Semester VII			**Semester VIII**		
ASTR	3103	Stars	ASTR	3113	Galaxies & Cosmology

Required Hours:		
	Physics	14
	Astronomy	9
	Mathematics	3
		26

AIMING HIGHER – GRADUATE DEGREES

Graduate students are vital to the success of a university. They not only assist with teaching and research, but they insure the "give and take" of the learning process with new ideas and new approaches to old problems. Friendships and collaborations formed in graduate school between students and professors last a lifetime.

If you want a degree beyond the bachelor level, certain preparations are needed now – during your undergraduate years. Graduate program admissions often require GRE scores, certain GPA levels on transcripts with a posted bachelor degree, a statement of purpose, 3 or more letters of recommendation, and TOEFL scores if English is not your native language. Since each graduate program may have its own special requirements, be sure to read the application materials carefully and ask questions.

GRE Scores

Most, if not all, graduate schools in the United States require students to submit scores from standardized Graduate Record Examinations (GRE), usually taken during the student's junior or senior year. We strongly recommend that you take the subject text in your junior year. Administered by Educational Testing Service (ETS), Princeton, NJ, the GRE consists of a general exam and a subject exam. The General Test measures verbal, quantitative, and analytical reasoning skills that have been developed over a long period and are not necessarily related to any particular field of study. The Subject Test measures achievement in a particular subject area and assumes an extensive background in the test discipline (physics is one of 16 subject areas tested). Recently, ETS expanded its testing schedules to include computer-based testing (CBT) along with the traditional paper-based testing. CBT is available for the general exam only and can be taken any time during the year. Paper-based testing for the subject exam (and general) is only offered for limited times each year stateside and requires a two-month advance registration. It is important for students wanting to enter graduate school to take these exams. You can visit GRE Online at *http://www.gre.org* to learn more about test dates and locations, sample test preparation materials, and costs associated with each exam.

When enough interest is shown, Professor Eric Abraham holds a series of study sessions for students planning to take the GRE. If you are interested in participating, contact Dr. Abraham for details.

Grade Point Average (GPA)

Usually, a cumulative grade point average of 3.00 on a 4.00 scale is required for full admission. Sometimes a lower GPA (2.75+) is considered if other factors indicate a good chance for success. You cannot be admitted to a graduate program if you do not have an undergraduate degree. Applications are usually reviewed with the understanding that a degree will be posted to an official transcript within a month or two of your graduation.

Statement of Purpose

Admission committees often want to know what a student's goals and objectives are when applying to graduate school. What do you hope to gain? Where do you want to be in 5 years? 10 years? What areas of research do you think you might be interested in? These are just some of the questions you may want to address in your statement.

Letters of Recommendation

Three letters from professors who know you and your abilities are usually needed. These are very important and are often the deciding factor on who gets into a program and how much financial support they may be offered. Now is the time to get to know your professors. Speak up in class. Participate in projects. Inquire about research opportunities. Make yourself known in a positive way.

TOEFL

Students whose native language is not English must often prove their abilities in writing and speaking English in order to get into a graduate program. Depending on the school, score requirements vary. Testing can sometimes be waived if a student takes a two-semester course in English as an undergraduate in an English speaking college or university and receives grades of "B" or better.

Financial Assistance

Graduate programs throughout the United States and the world actively recruit new graduate students. Teaching assistantships and research assistantships are awarded to many students to help finance their graduate studies. Stipends, fellowships, incentive recruitment funds, prospective student visits, etc., are just some of the financial inducements you may receive to select one program over another. Within our department, we currently offer first-year graduate students stipends of $15,300 for the academic year. In addition, we provide full out-of-state tuition waivers, partial in-state fee waivers and health care coverage. Other schools provide many of these same benefits – some more, some less.

Information Sources

Posters about physics, astronomy and engineering physics graduate opportunities are posted for 30+ days on the second floor bulletin boards in Nielsen Hall and then filed in an accessible cabinet located in the Student Study Lounge, room 301. Browse through the posters and booklets at your leisure. You will be surprised by the number of programs and variety of research areas available to interested students. Other good sources include the American Institute of Physics' *Graduate Programs in Physics, Astronomy, and Related Fields*, and *Peterson's Guides to Graduate Study - Book 4* and *Book 5*. These guides may be found in the reference section of the university's main library and in the Physics office.

DEPARTMENTAL SERVICES

Library

As you advance through the Physics curriculum, it is important that you begin to take responsibility for your own education, and learn to think for yourself. Learn to use the Physics and Astronomy Library (Nielsen Hall, room 240) to find and read texts that are relevant to your coursework but unassigned. Look through current periodicals to stimulate your awareness of what is taking place in the scientific community. Perhaps you will find some particular author who "speaks to you" – whose writings you can use to fill out your knowledge, to introduce you to some modern topics, or to help you understand ideas discussed in class. The student who learns to do this early is well on the way to becoming a good physicist.

Computer Lab

The department has a computer laboratory in room 150 of Nielsen Hall. This lab consists of personal computers networked together and connected to two laser printers. This facility is open to students for both general use and for class assignments. Current hours are 9:00 a.m. - 10:00 p.m., Monday through Thursday and 9:00 a.m. - 5:00 p.m. Friday. There are some times when the laboratory is reserved for meetings of classes and is not available for general use. Reserved times are posted on the door each week. The software available in the lab includes word processors, mathematical and graphics software packages, simulation programs, and programming languages. These are the sorts of computational resources that are generally available to scientists today.

Tutoring

The department offers free tutoring for all students enrolled in undergraduate introductory physics and astronomy courses (Astr 1504, Phys 1114, Phys 1205-1215, Phys 2414-2424, and Phys 2514-2524). An experienced graduate student is available in the Student Study Lounge (Nielsen Hall, room 303) at various times throughout the week during the fall and spring semesters. Current schedules are always available in the Physics Office.

Student Study Lounge

Nielsen Hall, room 303, is designated as the Student Study Lounge area during the fall and spring semesters. Occasionally, departmental talks and meetings are scheduled in this room, but primarily it is open and available to all students for study purposes during building hours (Monday through Friday, 7:00 a.m. – 10:00 p.m.).

JOB AND SCHOLARSHIP OPPORTUNITIES FOR UNDERGRADUATES

Departmental Opportunities

Faculty members with research grants often hire undergraduates to help with their research, generally during the summer. These positions are usually awarded on a first-come first-serve basis to good students. Undergraduates are also hired throughout the year to assist in the computer lab. Talk with your instructors and departmental advisors about opportunities.

Our department has operated a NSF Research Experience for Undergraduates site since 1996. Selected undergraduates from across the nation and OU work together with faculty in various areas of experimental and theoretical research. A stipend with partial room and board is offered during the nine-week program. All physics, astronomy, astrophysics and engineering physics majors are eligible to apply.

Off Campus Opportunities

Many colleges and universities around the country offer exciting summer internship programs and workshops. These opportunities are primarily for juniors and seniors but occasionally beginning students are invited to apply. As flyers arrive, they are posted on a second floor bulletin. Actual application materials are filed in the Physics office (room 100) and are available for viewing whenever the office is open. Office staff will copy any information you need to apply to the various programs. Application deadlines for these programs are usually early – January and February – so do not procrastinate if you are interested in summer research. Start checking in the office in December for the upcoming summer.

Departmental Scholarships and Awards

The J. Clarence Karcher Scholarship is funded through an endowment given to the Department of Physics and Astronomy honoring the late Dr. J. Clarence Karcher, a 1916 graduate of the Department of Physics and the inventor of reflection seismography. The scholarships are awarded on the basis of academic merit as evidenced by grades and achievement test scores. To be eligible for the scholarship, a student must be a declared major in one of our programs and must maintain a high level of academic performance. Awards are a minimum of $1400 per academic year ($700 if the student has a general university-administered academic scholarship in the amount of $700 or more) and are renewable through the senior year of study for a maximum of 8 semesters if a high level of academic performance is maintained. An initial application form is available through the Department Office.

The Roy B. Adams Engineering Physics Scholarship was first awarded in May 1999. This annual scholarship (typically $1500) is available to Engineering Physics majors with at least 30 semester hours and a cumulative GPA of 3.00 or better. Application is associated with *The J.Clarence Karcher Scholarship* form.

The Cuba and Ted Webb Scholarship, established in 1997, is funded through a generous gift from Cuba and Ted (BS Physics, 1951) Webb. The $1500 scholarship is presented annually on the basis of

merit and need to an outstanding upper-division undergraduate student majoring in astronomy, astrophysics, physics or engineering physics. Applications are available in the Department Office at the beginning of each spring semester.

The Fowler Prize (established in memory of the late Richard G. Fowler, Professor Emeritus, Department of Physics and Astronomy) is presented annually to the outstanding graduating senior in our Department. The Prize carries with it a plaque and a monetary award of $1000.

The Homer Dodge Award, The Duane Roller Award, and *The J. C. Karcher Award* are presented annually to the outstanding sophomores, juniors and seniors in Engineering Physics and in Physics/Astrophysics. Each spring, students in all our degree programs who have exhibited meritorious scholarship are recognized at a special departmental awards ceremony.

General Scholarships

General Scholarships are awarded through the Financial Aids Office of the University of Oklahoma. Lists of available general scholarships for the College of Arts and Sciences, College of Engineering, and University-Wide are on the following pages. For a complete listing of all scholarships and specific requirements for each, contact the Financial Aids Office for a copy of their current booklet entitled, *A Guide To Financial Aid and Scholarships At The University Of Oklahoma*.

SCHOLARSHIPS ADMINISTERED BY THE OU OFFICE OF FINANCIAL AID SERVICES

College of Arts and Sciences – General Scholarships

A.R. Bert Larason Public Service Scholarship
Alice Allen Everett American Indian Scholarship
Alvin Terrell Dixon Memorial Scholarship
Amy Taylor Sewell Memorial Scholarship
Friends of the College of Arts and Sciences
Heather Marie Goff Memorial Scholarship
Herbert A. and Lela Mitchell Berlin Scholarship
J and J Stevens Scholarship
Jack Roe Denton Memorial Scholarship
Leadership Scholars Program
Patti Johnson Wilson Scholarship
Phi Beta Kappa Junior Scholarship
Robert C. Thomas/Tenneco Gas Scholarship
Ruby M. Brakebill Scholarship
Sequoyah Heritage Award

SCHOLARSHIPS ADMINISTERED BY
THE OU OFFICE OF FINANCIAL AID SERVICES
College of Engineering – General Scholarships

Alex H. and Delores Massad Engr. Scholarship
Allan and Marilyn Neustadt Engr. Scholarship
Andersen Consulting Engr. Scholarship
Bill and Mary Crynes Engr. Scholarship
C.H. Guernsey and Co. Engr. Scholarship
Carl A. Bentley Scholarship
Charles C. and Maxine W. Ingram Engr. Scholarship
Charles E. Foster Engr. Scholarship
Charles L. Blackburn Engr. Scholarship
Clyde J. Cecil Scholarship
Conoco Leadership Scholarship Program
Darryll G. Prince Memorial Scholarship
Dean's Scholarship for Incoming Freshmen
Dean's Scholarship for Transfer Students
Dick and Shirley O'Shields Engr. Scholarship
Distinguished Alumni Scholarship for Incoming Freshmen
Distinguished Alumni Scholarship for Transfer Students
Dusty and La Fawn Biddle Engr. Scholarship
Edna Neil Scholarship
Edward A. and Nancy K. Blair Engr. Scholarship
Enserch Engr. Excellence Internship program
Fred Wilson and Gertrude Hayes Close Engr. Scholarship
Harold K. Bone Memorial Engr. Scholarship
Harry W. Denton Memorial Scholarship
Henry B. Wilson Engr. Scholarship
Honda of America Engr. Scholarship
Jack H. Abernathy, Sr. Engr. Scholarship
Jack L. and Medora Blanton Engr. Scholarship
James R. Lesch Engr. Scholarship
Jere W. McKenny Engr. Scholarship
Jerry D. Holmes Engr. Scholarship
John A Brock Engr. Scholarship
John H. Moore Engr. Scholarship
John M Houchin Engr. Scholarship
John T. Stupka Engr. Scholarship
Jon R. Withrow Engr. Scholarship
Kendall Carrol Purgason Endowment Scholarship
Kenneth L. Smalley Engr. Scholarship
Lawrence G. Rawl Engr. Scholarship
Lew and Myra Ward Engr. Scholarship
Linda R. Dunham Engr. Scholarship
Maples Family Scholarship
Mary Ann Phelps Knowles Scholarship
Milton J. Gordon Scholarship
Minority Engr. Dean's Scholarship for Incoming Freshmen
Minority Engr. Dean's Scholarship for Transfer Students
Minority Engr. Distinguished Alumni Scholarship for Incoming Freshmen
Minority Engr. Distinguished Alumni Scholarship for Transfer Students
Minority Engr. Program Scholarship
MRE Consulting Engr Scholarship
Nations Bank Engr. Scholarship
Oklahoma City/Tulsa Chapter of Gas Processors Association (GPA)
Oklahoma Engr. Foundation Scholarship
Patti Johnson Wilson Scholarship
Rainbolt Family Engr. Scholarship
Ray G. Collins Engr. Scholarship
Richard G. Askew Engr. Scholarship
Richard L. O'Shields Engr. Scholarship
Robert W. Hughes Engr. Scholarship
Robert C. Thomas/Tenneco Gas Scholarship
Rudolph Alexander Engr. Scholarship
SAE Engr. Scholarship
S.J. Cerny Engr. Scholarship
Sam J. Cerny Freshman Engr. Scholarship
Sam A. Wilson Engr. Scholarship
Sam A. Wilson Memorial Scholarship
Sandra S. Talley Engr. Scholarship
Society of Amer. Military Engrs. New York City Post
Sonat Foundation Minority Engr. Scholarship
Steven and Lynn Fisher Engr. Scholarship
Ted S. and Cuba Webb Scholarship
Thomas H. McCasland, Jr. Engr. Scholarship
Tom J. Love, Jr./Geis Family Engr. Scholarship
W. D. Owsley Scholarship Award
Walter A. and Claire E. Bork Engr. Scholarship
William H. Barkow Engr. Scholarship
William Miller Peck, Jr. Engr. Scholarship
Zarrow Engr. Scholarship

SCHOLARSHIPS ADMINISTERED BY THE OU OFFICE OF FINANCIAL AID SERVICES

General Scholarships – University Wide

Advantage Scholarships
Alumni Scholars
Andrew W. Mellon Fellowship in Humanistic Studies
Auditing of Classes by Senior Citizens
Award of Excellence
Barry M. Goldwater Scholarship
Campus Activities Council Scholarship
David A. Burr Most Outstanding PLC Alumni Scholarship
David A. Burr Outstanding PLC Award
Generations
Harry S. Truman Scholarship
Honor Scholar
John S. & Charles F. Barwick Scholarship Fund, Inc.
Kerr-McGee Scholarship
National Achievement Scholarship
National Guard Resident Tuition Waiver
National Merit Scholarship
National Scholar Non-Resident Tuition Waiver
National Scholar Resident Tuition Waiver
Oklahoma Academic Scholars
Oklahoma Memorial Union Board of Trustees Scholarship
Oklahoma NASA Space Grant Consortium OU Scholarship (OSLEP)
Oklahoma Rural Rehabilitation Corporation Scholarship
OU Scholars
Phi Beta Kappa OSLEP Scholarship
Phi Kappa Phi OSLEP Scholarship
Phi Theta Kappa Alumni Association
Phillips Minority Scholars Program
President's Leadership Class
President’s Special Recognition Award
R. Boyd Gunning Scholarship
Recruitment Intern Scholarship
Regents Scholar
Retention Intern Scholarship
Rhodes Scholarship
Sylvia Lewis General Scholarship Fund Award
Transfer Academic Excellence Award
Transfer Leadership Class Scholarship

University Scholar

University Achievement Class
Valedictorian Scholar
Vietnam Memorial Scholarships-Captain Riley L. Pitts Commemorative Scholarship
William D. Whitehurst UOSA President's Scholarship Fund

EXTRA-CURRICULAR ACTIVITIES

Society of Physics Students (SPS)

SPS is a national student organization for physics, engineering physics, astrophysics and astronomy majors, both graduate and undergraduate, as well as anyone else interested in physics. Besides regularly scheduled meetings, activities include pizza parties, colloquiums by professors, annual spring picnic, out-of-state conference opportunities, etc. SPS provides an informal setting for meeting other students with similar interests. For the freshman and sophomore, upper-classmen can give help, insight and guidance into lower level courses. For juniors and seniors, SPS provides graduate school and job-related information.

For meeting and activity dates, contact the department sponsor, Matthew Johnson, Associate Professor of Physics, or leave a message in the SPS mailbox in the Department Office.

Alpha Sigma Kappa (ΑΣΚ)

Alpha Sigma Kappa is a professional organization for women in technical studies. A schedule of current activities as well as membership requirements may be obtained from the group's advisor, Melissa Rieger, Assistant Professor in Chemical Engineering, Sarkeys Energy Center, room T219.

Students for the Exploration and Development of Space (SEDS)

This relatively new campus organization is a chapter of the national SEDS organization. SEDS is dedicated to informing and promoting all aspects of space exploration – including astronomy, space travel, and exploitation of space resources. Students from all majors who have any interest in space are welcome to join. See Dr. Bill Romanishin, Associate Professor of Physics and Astronomy and the SEDS faculty sponsor, for more information.

APS Membership

The American Physical Society offers a free one-year trial membership in APS to undergraduate and graduate students enrolled in physics or a related degree program. This free trial is for full time students who have never been an APS member nor received the offer previously. Membership benefits include a free subscription to *Physics Today*, monthly magazine containing news of physics and articles of interest to the physics community. Interested students may pick up an application form in the Department Office.

Colloquia

Most Thursday afternoons at 4:00 p.m. - fall and spring semesters - the department hosts a colloquium (an academic seminar on a broad field of study led by a guest lecturer). A different speaker is invited each week to present their particular area of research or study. Although many of the discussions may be too technical for beginning undergraduates to understand, these informal talks provide an opportunity for students to meet local, national and international scientists and hear many different viewpoints. Everyone is invited to attend.

Departmental Tea

During the fall and spring semesters, the department holds a daily "tea" from 3:30 to 4:00 p.m. Cookies, lemonade, coffee and tea are served each day in the first floor foyer of Nielsen Hall. To help defray expenses, a semester fee of $15.00 for staff/graduates students and $30.00 for post-docs/faculty is collected from those who wish to attend every day. Tea is open to everyone and provides an informal, relaxed setting for faculty, staff and students to visit with one another and exchange views.

Fall Picnic

Annually, the department enjoys a friendly, relaxed family picnic at a faculty member's home. This potluck affair brings together faculty, staff, graduate students, undergraduate students, and their family and friends for good food and good conversation. In addition, the afternoon offers swimming, Frisbee and a good game of volleyball for those who want to participate. A detailed flyer is distributed in mid-September and sign-up sheets can be found in the Physics office.

Awards Day

The department honors outstanding undergraduate students each spring at a special Awards Day ceremony and reception. Everyone is invited to this well attended event.

CAREERS

What do Physicists and Astronomers do?

Physics offers challenging, exciting, and productive careers. As a career, physics covers many specialized fields – from acoustics, astronomy, and astrophysics to medical physics, geophysics, and vacuum sciences (see Overview of Some Fields of Physics on the next two pages). Physics offers a variety of work activities – lab supervisor, researcher, technician, teacher, and manager. A person trained in physics acquires a set of skills that makes him or her a valued employee in many settings. Physics opens doors to employment opportunities throughout the world in government, industry, schools, and private organizations. Even students, who elect not to pursue research or teaching positions, will find physics is an asset recognized by medical schools, law schools, and business schools.

For research positions and for college and university teaching, the PhD degree is generally required. High-school teachers, who need at least a bachelor's degree, are likely to be in especially strong demand in the future. If you are science-oriented and people-oriented, high school physics teaching is a career worth considering.

As might be expected, the starting salaries for physicists are higher at the higher degree levels. At each degree level, the physicist commands a higher salary than the average of his or her peers in other fields.

While many of our graduates decide to go on to graduate school, others opt for immediate employment. Past BS degree graduates have entered the job market in positions with government agencies such as NASA and private companies such as Texas Instruments. Some major companies that regularly hire BS and MS degree physics, engineering physics and astronomy students into entry level positions include Raytheon, “E” Systems, Dow Chemical Company, Boeing Corporation, Honeywell, Polaroid, Microsoft Corporation, National Institute of Standards & Technology, Smithsonian Institution, Tennessee Valley Authority, Union Carbide Chemical & Plastics Company, and on and on. A complete list of companies that recruit our graduates is available in the University's Career Services office located in the Oklahoma Memorial Union.

Through the years, our graduates have included one president of a state university, one U.S. ambassador, one director of the National Science Foundation, five founders of corporations, one famous Arctic explorer, the founder and first editor of *The American Journal of Physics*, three other journal editors, three inventors, eight research lab managers, eight departmental chairpersons, one Rhodes Scholar, two Guggenheim Fellows, 80 university professors, and more than 500 other people devoted to advancing knowledge and improving the quality of life.

Employment lists of recent degree recipients on the final pages of this handbook indicate some of the job opportunities, locations and salaries our graduates receive.

OVERVIEW OF SOME FIELDS OF PHYSICS

Acoustics - the study of sound. An acoustical physicist could be involved in the design of a concert hall, stereos, or synthesizers.

Astrophysics - the extension of basic physics into the cosmos. Astrophysicists study the life cycles of stars and the processes that gave rise to our expanding universe at the moment of the "big bang."

Atomic physics - the study of atoms and their dynamical properties. The use of lasers, molecular beams, and high precision detectors has made new discoveries possible in this area.

Biophysics - the application of physics to biological problems. Biophysics includes studies of proteins and DNA at the molecular level as well as studies of the human body as a mechanical system and the design of artificial limbs.

Chemical physics - the interface between physics and chemistry. This area is important for the development of lasers and for the study of surfaces, polymers, and fluids.

Geophysics - the physics of the earth and planets, including seismology (the study of earthquakes), hydrology (the study of water on and below the surface), and volcanology (volcanoes).

Low-temperature physics - the study of phenomena such as super-conductivity and superfluidity that occur at temperatures near absolute zero. Cryogenic (extreme low-temperature) devices have practical importance in generating magnetic fields and in circuits that will be needed in future computers.

Medical physics - the application of physics to medical practice, including uses of radiation, ultrasound, and sophisticated imaging techniques such as magnetic resonance imaging (MRI).

Nuclear physics - the study of the nucleus of the atom, its radioactivity (including medical applications), and nuclear energy. Tools of the nuclear physicist include accelerators and nuclear reactors.

Optics - the study of light (including the invisible ultraviolet and infrared radiation). Optical physicists often work with lasers and are engaged in the optical transmission of information via thin fibers and in the design of optical "circuits" for future computers.

Particle physics - the study of the smallest, most elemental building blocks of nature and the basic forces of nature. The "microscopes" of the particle physicist are enormous particle accelerators. (Particle physics is also called high-energy physics.)

Physics education - Teachers experience the excitement and fulfillment of educating others about all the fields of physics.

Plasma physics - the study of electrically charged (ionized) gases, sometimes called the fourth state of matter beyond solids, liquids, and gases. Plasma physicists are pursuing the possibility of controlled thermonuclear energy on earth. They also contribute to astrophysics.

Rheology - the study of the flow of viscous (thick, sticky) materials and mixtures of materials. The interests of rheologists include the flow of blood in the body, the flow of materials in a food-processing plant, and the flow of Arctic glaciers.

Solid-state physics - the study and application of the electric, magnetic, optical, and acoustic properties of solid matter. Integrated circuits are the product of solid-state physics.

Vacuum physics - the study and applications of vacuums, volumes nearly free of matter. Vacuums are important in many manufacturing processes and in experimental devices such as accelerators.

Some of these fields are taught in our department. Some are taught by other departments on the Norman campus or at the Health Science Center in Oklahoma.