UHCL Graduate Physics Student Handbook

Fall 2020 Edition

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General College Guidelines

1. Assistantships

1.1. Teaching Assistantships

1.1.1. Responsibilities

The main responsibility of Teaching Assistants is to assist the primary instructor of the course. Activities may include: holding office hours, grading papers or exams, conducting lab sessions, assisting in studio courses and providing supplemental instruction. Standard half-time Teaching Assistants are expected to work 16-20 hours per week during the term of appointment. Quarter-time Teaching Assistants are expected to work 8-10 hours per week. In order to be eligible for a Teaching Assistantship, graduate students need to be enrolled in at least 6 SCH's during the long semester or 3 SCH's during the summer semesters. In addition, TA's need to be in good academic standing with a GPA of at least 3.0.

Examples of main responsibilities	• hold office hours • grade papers or exams • conduct or assist with lab sessions • assist in studio courses • provide supplemental instruction
Standard half-time TA work expectations during appointed term	16-20 hrs/week
Quarter-time TA work expectations during appointed term	8-10 hrs/week
SCH enrollment requirement	• at least 6 SCH's during the long semester (Fall or Spring) • 3 SCH's during the summer semesters
GPA requirement	good academic standing with a GPA of at least 3.0

1.1.2. Appointment Process

Graduate Students my apply for Teaching Assistantships by filling out the forms available from the Department Secretary. Students should be sure to include their resume with their application.

1.1.3. Assessment

Each Semester Teaching Assistants will be evaluated by their supervising faculty member.

1.1.4. Compensation

Half-time Teaching Assistants are paid a rate of at least $3000 per semester and are given in-state tuition waivers. Half-time Teaching Assistants are also eligible to enroll in the university's group medical insurance program. Quarter-time Teaching Assistants are paid a rate of at least $1500 per semester and are not eligible for in-state tuition waivers or enrollment in the university's group medical insurance program. Teaching Assistants may be paid more based on their assigned responsibilities.

1.2. Research Assistantships

1.2.1. Responsibilities

The primary responsibility of a Research Assistant (RA) is to assist a faculty member in conducting their research. Eligibility requirements are the same as those for teaching assistants.

1.2.2. Appointment Process

Research Assistants are funded through the sponsoring faculty member's grants. These may be internal grants provided by the college or external grants provided by other agencies. The application process for an RA is similar to that of a TA except that the process often starts with a conversation between the student and faculty member. The application is available from the Department Secretary and online at https://www.uhcl.edu/science-engineering/documents/cse-ra-application.pdf.

1.2.3. Assessment

Research Assistants are evaluated by the sponsoring faculty member each semester.

1.2.4. Compensation

Research Assistants are paid a rate of at least $3000 per semester and are given in-state tuition waiver. Research Assistants are also eligible to enroll in the university's group medical insurance program.

2. Candidate Plan of Studies and working with your Faculty Advisor

2.1. Purpose of CPS

The purpose of the Candidate Plan of Study (CPS) is to track each student's progress towards degree completion. It spells out the specific requirements needed to complete the degree and can only be changed by the mutual consent of both the student and advisor. The official CPS is kept in the CSE Dean's office but students are encouraged to keep their own copy. The process of creating a CPS typically starts a few months after a student arrives on campus. Creating the document begins with a meeting between the student and their faculty advisor. They will fill out a CPS worksheet where it will be determined when the student will take what classes and which capstone option will be selected.

2.2. Scheduling Appointments with your Faculty Advisor

Every graduate student is assigned a faculty advisor when they are admitted to the program. The name of the faculty advisor, along with their email address, is listed on each student's admission letter. Students are responsible for arranging initial appointments with their faculty advisor. Students can talk to any full-time faculty member about any program-related issues, but their faculty advisor is their main point of contact with respect to their degree progress. If needed, a student can change their faculty advisor by filling out a request form in the Dean's office.

2.3. Questions to ask your advisor

During your first meeting with meeting with your advisor, you may want to discuss issues such as: long-term career goals, areas of research interest, preparation for Doctoral programs or the work-force, time constraints in completing the degree, financial constraints, any issues making attendance difficult, disability status, etc... You are not obligated to work on a research project or thesis with your faculty advisor.

The most important decision in CPS process is whether you will do an MS thesis or choose instead the extended coursework option (and capstone course). The decision should be based on your long-term goals including plans for pursuing a PhD and your interest in and aptitude for research. Your advisor will assist you in making that decision.

3. Research Opportunities

3.1. Purpose of research at UHCL

As UHCL is considered a Teaching University, the primary purpose of research is for the educational enhancement of our students. As such, faculty see student involvement in research as a learning opportunity and should be encouraging and supportive. Any results such as the publishing of articles or the awarding of grants is considered secondary to student learning outcomes.

3.2. On-Campus vs Off-campus research

Because of our proximity to NASA and high-tech industry, there are often opportunities for students to pursue research off-campus. For the purposes of thesis and non-thesis work this is not distinguished from on-campus research. Students should however make sure their Faculty Advisor and the Program Chair are aware of any research they are involved in that does not involve a full-time UHCL faculty member.

3.3. Finding Research Opportunities

Research opportunities are often passed on by UHCL Faculty Members, Members of our Advisory Board, the UHCL Career Services office, and sometimes by student organizations. If a student is interested in off-campus research opportunities, they should let their faculty advisor and their Program Chair know.

4. Dispute Resolution

4.1. Informal Resolution with Instructor

In the interest of the program, we take dispute resolution very seriously. Whenever possible, it is preferable that students resolve any issues with their instructor directly. This is best done during the faculty member's office hours or before/after class when the discussion can be done privately. It is advisable that after such a conversation, either the student or faculty member follows up with a clarifying email as to what was discussed and what resolution, if any, was reached.

4.2. Escalating Issues to the Chair

If a student is unsuccessful in resolving an issue with the instructor, the next step is to escalate that dispute to the Program Chair. The student should arrange to meet with the Program Chair or send him or her an email stating the issue. UHCL has a strict no-retaliation policy so students should never worry about reporting an issue with a faculty member. Issues brought up to other faculty members, such as faculty advisors, will be sent to the Program Chair for resolution as if the student reported them directly to the Program Chair. The Chair's duty is then to investigate the issue, listen to all sides and

develop a resolution. If the Program Chair cannot resolve the issue, he or she may go to the Department Chair or other members of the College Administration for help.

4.3. Escalating Issues to Dean/Associate Dean

Beyond the Program, issues must be written in order to be considered by the Dean/Associate Dean. This may take the form of an email and the student is again protected by a no-retaliation policy. Before sending a complaint to the Department Chair, Associate Dean or Dean, please be sure to try working within the Program to solve the issue first.

4.4. Escalating Issues beyond the CSE Dean's Office

In extreme cases, issues may need to be escalated to the Provost or President. In these situations, the issue must be in writing and the Program/College should have had the opportunity to address the issue. In cases where the upper administration receives a student complaint, they rarely investigate it if the college was unaware of the complaint. Normal policy requires ending the complaint to the program, department or college where it originated and not reviewing the issue until it has been investigated at those levels.

5. Co-ops and Internships

5.1. Finding an Internship or Co-op

UHCL has made a conscious decision to centralize all internship information into one office, the Office of Strategic Partnerships. This office maintains a database of all internship information and vets each company before they can hire UHCL students as interns. This makes it straight-forward for students to identify potential internships and know they are with reputable organizations.

5.2. Application Process

Once a student identifies an internship, they will need to get an offer letter from the organization and fill out the appropriate UHCL internship documentation. The Office of Strategic Partnerships is available to help with the process. In addition, students need to meet basic GPA and residency requirements in order to qualify. The application process generally takes a few weeks so students should be sure to start early.

5.3. Assessment of Experience

Each internship will have a UHCL faculty member as instructor of record as well as a supervisor on the internship. Both the student and supervisor will need to fill out a

survey of the experience in order to assess the student and the internship site. Some programs also require that students complete an oral and/or written report after returning from their internship. If there is a problem at any time during the internship, the student should let the faculty instructor of record know immediately. In addition, if the internship is outside of the United States, it should be registered with the study abroad program.

6. Independent Studies

6.1. Purpose of Independent Studies

Independent studies are often used in emergency situations or whenever teaching a regular course is impractical. Independent study courses should have a syllabus, assessments and learning objectives like traditional courses. UHCL faculty are working to ensure that we teach as few independent study courses as possible although we will teach them as necessary.

6.2. What can and can't be used for independent studies

In some situations, a student may need a course to graduate but that course will not be offered in its regular rotation for several semesters. In that situation, an independent study may be used. Independent studies may also be used if a regularly scheduled course does not make due to low enrollment. Independent studies are not meant to be used for research experiences or for elective courses. They are also not meant to be used for courses which would be offered under normal rotation during the next semester.

6.3. Application Process

All Independent Study courses must be approved by the faculty member teaching them, the Program Chair, Department Chair and Associate Dean of the College. This process starts with filling out an independent study form with the instructor and the instructor providing some justification of the independent study to the Program Chair.

7. Other Issues

7.1. Sexual Misconduct

This is one of the least fun but most necessary topics in any university manual. Sexual Misconduct is defined as unwelcome sexual advances, requests for sexual favors and other verbal or physical conduct of a sexual nature. Every university has a specific policy on dealing with sexual misconduct, which should outline the rights and process for every party involved in a sexual misconduct dispute. Graduate

students should be aware of this policy because 1) as students, they could be the victim of sexual misconduct 2) as teaching assistants, they could be accused of sexual misconduct. Sexual misconduct is not limited to male-female interactions or even interactions between teachers and students. In order to avoid false allegations, it is recommended that teachers should never have closed-door private meetings with students and should not have official course related meetings off-campus. Be sure to familiarize yourself with the university's policies concerning sexual misconduct. https://www.uhcl.edu/policies/title-ix/

7.2. Campus Services outside of the Program

Beyond your academic Program, UHCL offers a wealth of services that are designed specifically to help students become as successful as possible. Whether you need help with your writing or to prepare for a job interview, please be sure to look towards these resources. Most are found in the Division of Student Affairs at https://www.uhcl.edu/student-affairs/.

Physics Program Specific Items

8. Degree Plans

8.1. Staying on schedule

Students are ultimately responsible for monitoring their degree progress. Faculty are often only aware that a student is behind schedule in extreme cases. While full-time students typically graduate in 2 years, part-time students can take over 3 years. Students should be careful to monitor their time to degree as classes effectively expire after 5 years and then require administrative approval to count towards the degree.

8.2. Standard MS Degree

The Standard MS in Physics Degree consists of 36 total credit hours. This includes 24 credit hours of core courses (4 hours each), up to 6 credit hours of electives and at least 6 credit hours of either Thesis or Capstone Courses. Our curriculum is similar to that of other Physics MS programs as well as that of the first 2 years of a Physics PhD program. The goal of this program is to prepare students to continue with a Physics PhD and to expand their knowledge beyond what one would see in a typical Physics Bachelor's degree program.

8.3. Technical Management Option

The Technical Management option was developed specifically to prepare students for careers in industry and not further study in Physics. It is similar to our standard MS, however only 1 semester of Quantum Mechanics is required, and the elective courses are all taken from Management, Systems Engineering and Engineering Management. Also, the Thesis option is not available with the Technical Management option. Students complete the degree by doing either an internship or completing one semester of the capstone class.

8.4. Collaborative Physics PhD Program with UH

The purpose of the Collaborative Physics PhD Program with UH is to make it easier for UHCL Master's students to transition into a PhD Program. This program is similar to the standard Physics MS with regards to the core courses. However, students interested in this program can take UH candidacy exams in August and January of each year in order to earn candidacy in each of the six core areas. In order to join this program students should talk to the UHCL Physics Program Chair. Students who complete candidacy through this program at UHCL and choose not to finish the master's degree can apply for a Physics Candidacy Certificate from UHCL.

9. Assigned Foundation courses and waivers

9.1. Purpose of Assigned Foundation Courses

During the admissions process, students are often are assigned foundation courses if they have some deficiencies in their undergraduate background. These are typically undergraduate physics courses ranging from Modern Physics to more Advanced Majors courses such as Quantum Theory or Electromagnetism. If you believe that you were assigned these foundation courses in error, it is possible to have the requirements waived.

9.2. How to get a Foundation Course Waived

Foundation courses may be waived by the Physics Program Chair. The process of receiving a waiver typically consists of the student sending a request to the Chair on the grounds of previous coursework taken or demonstrated experience. The Chair may then request additional information such as syllabi of courses taken or arrange for a test-out of the material to be done.

10. Core Courses

10.1. Common Structure for all core courses

Each core course consists of a 1-credit hour recitation section and a 3-credit hour lecture session. Faculty may choose to utilize this recitation section in different ways, but it is primarily intended as a question and answer session for working out example problems not covered in the lecture. Because of this 4-credit hour structure, graduate students are expected to take no more than 2 core courses in any given semester. In order to graduate, a C or better is required in each of the core courses.

10.2. Mathematical Methods in Physics - PHYS 5531/5511

About 54% of Ph.D. level physics departments require at least one semester of Mathematical Methods. Math Methods is a prerequisite for many of the other core graduate physics courses and is typically the first course taken by part-time graduate students. The purpose of this course is to prepare students to complete the other graduate-level courses by reviewing and teaching the mathematics that are needed for the other classes. We view this course primarily as a review; so don't expect to learn all the material if this is the first time you are seeing these topics. The material, covered in this course, depends primarily on the preference of the professor and background of the students. It is offered every fall semester.

10.3. Electrodynamics - PHYS 5331/5311

About 89% of Ph.D. level Physics departments require at least one semester of Electrodynamics. This course is based partially on the work of Maxwell in the mid 19th century but also includes topics from 20th-century research. The mathematics used in this course primarily consists of vector calculus, differential equations, Green's functions, Fourier transforms, complex variables, special functions and tensors. A good understanding of mathematical methods is essential here. The most popular textbook used in this class is the one originally written by J.D. Jackson in 1962.

10.4. Classical Mechanics - PHYS 5431/5411

About 77% of Ph.D. level Physics departments require at least one semester of Classical Mechanics. Classical Mechanics is based primarily on pre-20th-century physics, first developed by Newton hundreds of years ago. The mathematics used in this course is primarily calculus of variations and differential equations although many of the other Mathematical Methods topics are also used.

10.5. Statistical Mechanics - PHYS 5731/5711

Approximately 85% of Ph.D. level Physics departments require at least one semester of Statistical Mechanics. Statistical Mechanics is essentially a generalization of Thermodynamics, which seeks to understand the behavior of more particles than can be understood using classical or quantum mechanics. It mostly utilizes probability & statistics and differential equations. The material ranges from classical gas dynamics developed prior to the 20th century and quantum statistics developed during the 20th century.

10.6. Quantum Mechanics 1 and 2 - PHYS 5631/5611 and PHYS 5632/5612

About 91% of Ph.D. level Physics departments require at least one semester of Quantum Mechanics. Most programs, like UHCL, require two semesters. The mathematics used in Quantum Mechanics typically consists of differential equations, linear algebra, tensors, probability & statistics and Fourier transforms. The material consists mostly of physics developed during the mid-twentieth century.

11. Electives

11.1. Purpose of Electives within the Program

There are traditionally two reasons for taking an elective course in physics. 1) To broaden the knowledge base of students and 2) to prepare students for advanced work within a specific sub-discipline. Because the UHCL Physics Program does not offer a PhD

in Physics and has a limited capacity to offer large numbers of elective courses, we focus on the first reason. Electives within the Physics Program are offered on a semi-regular schedule although the choice of electives may depend on Program resources and student interest. If you need help choosing an elective course or want to know which electives are being offered on what schedule, please feel free to reach out to your faculty advisor, Program Chair or any other member of the faculty.

12. Thesis/non-Thesis options

12.1. Thesis Option Overview

The Thesis option is a traditional thesis which requires a committee of three faculty and a formal defense. Program policy states that at least 2 of the thesis committee members be full-time members of the program. While the thesis option allows a student to get more deeply involved in research, there is no guarantee that a student can complete a thesis within a specified amount of time. Also, because of the limited number of faculty and resources within the program, not every student will be able to complete a thesis within the program. In some cases, the thesis may be advised by a researcher external to the program.

A student interested in the Thesis option should take PHYS 6837 Research Project & Seminar I in their 2nd semester in the program (usually Spring of their 1st year). In that class, they will write their Thesis Proposal and have it approved by their thesis advisor and committee before signing up for PHYS 6939 Master's Thesis Research in their 3rd semester (usually Fall of their 2nd year). A student can then complete their Master's Thesis in their 4th semester (usually Spring of their 2nd year). Students signed up for the thesis option should provide a progress report to their committee every long semester they are enrolled in thesis until they graduate. These progress reports may be used to evaluate whether the student is making significant progress or if they should consider switching to the non-thesis option. Please keep in mind that there is no guarantee that a thesis will be completed by the end of the 2nd year. It may take a longer time depending on work ethic and circumstances that may be beyond the student's and program's control.

12.2. Non-thesis Option Overview

The non-thesis option consists of a two-course sequence PHYS 6837 Research Project and Seminar I and PHYS 6838 Research Project and Seminar II. Over this 2-semester sequence, students will work on a research project and write it up in the form of a journal article. The courses also incorporate our annual seminar series in order to help students learn how to communicate about science effectively and gain exposure to different areas of physics research. The non-thesis option can be reliably completed within 2 years and does not require a formal defense. Students who switch from the

Thesis to non-Thesis option can graduate by completing PHYS 6838 after taking PHYS 6837.

12.3. Choosing the best option for you

Many physics departments offer both thesis and non-thesis options for completing the Master's degree while the Ph.D. can only be completed with a thesis. The non-thesis option usually consists of a research project that may be as simple as assisting a faculty member with his or her work but can lead to a publishable article. We find that the non-thesis option works better for part-time students. Thesis work tends to be much more involved and the time commitment is more than most part-time students can handle. The advantage of the thesis is that the work can sometimes be extended into Ph.D. research. The thesis also gives a student time to become much more focused on a specific research interest. A good master's thesis can usually be published.

Students should choose a research project based on their interests, abilities and time restrictions. In addition to choosing a subfield, students need to decide if they want to do theoretical, computational or experimental research. Theoretical research projects tend to require a much more sophisticated mathematics background than experimental research. Computational work is often placed in the same category as theoretical research but requires more computer and less mathematical skills. The advantage of theoretical (or computational) research for some students is that work can be more flexibly scheduled than experimental work. Experimental work requires a physical laboratory, expensive equipment, and almost all the work must be completed in the lab but is excellent experience for students who like to work with their hands. This time restriction makes experimental work difficult for many part-time students. We recommend that non-traditional students work on either theoretical/computational research projects or try to find a project that can be completed at their place of employment. There are also many interesting problems that can be solved on a computer (in astrophysics for example) that could never be solved experimentally. Data analysis projects are another alternative for part-time students but may not be significant enough for Ph.D. level work.

13. Other Issues

13.1. When should I register for classes?

Students should register for classes as soon as possible. Because graduate courses in physics tend to be small, most students think that there is no harm to wait until the last minute (or even after the class starts) to register. The counterpoint to this is that because graduate physics courses tend to be small, they are more likely to be cancelled because of low enrollment. Don't forget that education is a business and universities can't justify offering a class with less than 5 (or 10) students. If you cannot register for a class until late in the registration process for any reason, we

recommend you email the professor to declare your intent to register. You don't want to be that one person who caused the class to be cancelled. Also, if you are thinking about delaying registration because you are waiting for a financial aid or fellowship check, be sure to check the university's policy on tuition payments. While most students think they have to pay as soon as they register, the fact is, most universities like UHCL have a census date when you are officially dropped for lack of payment. This tends to be about 12 days into the semester and is the real deadline for making a tuition payment.

13.2. How much time should I devote to studies?

The time required to be successful in a graduate-level physics course depends on many variables. A student's level of preparation, their ability to focus on the course, their level of maturity, and their ability to work in groups, all factor into how much time a student will need to spend on a course. A typical graduate-level physics course at UHCL requires about 10-15 hours per week for a well-prepared student.

A full-time student should expect to spend about 30-45 hours per week on his or her courses. A part-time student, who works full-time, should only take 1 or 2 courses per semester. We sometimes see students who work full-time and attempt to take 3 courses. These students are rarely successful. Online courses will require about the same time commitment. Although there is a significant amount of time required for these courses, most students have the freedom to choose when to devote time to their studies. Because of this, graduate school requires excellent time-management skills. We recommend using your Outlook Calendar to schedule time devoted to research and study in addition to class time.

Student research should take about the same amount of time per Semester Credit Hour (SCH) as face-to-face courses. A typical independent study or thesis could take anywhere from 10-20 hours per week depending on how many credits you register for. Thesis work, whether for a Bachelors, Masters or Ph.D. typically requires more time and focus than students think. Before considering a thesis, try to imagine how many hours you think the project will require per week and multiply that by two or three. If you cannot devote that much time, you may want to reconsider the project.

13.3. Should I attend Full-time or Part-time?

Most universities don't provide a part-time option. UHCL, however, does give this option so we feel confident in discussing it. Traditional physics graduate students may devote over 60 hours per week to study, teaching and research. This allows students to become fully immersed in their subject, which has a net positive impact on learning.

We feel that part-time students bring a lot to the table. They tend to be more mature; have more practical work experience and tend to be more organized with their time.

When deciding whether to pursue graduate education full-time or part-time, one must weigh several items: time to complete the degree, economic situation, chance of success and career goals. Full-time students complete degrees in fewer semesters and have a better chance of getting good grades. However, not all students can go to school full-time. Many part-time students have families and have already made significant progress in their careers. They can't afford to go to school full-time from a practical standpoint.

Ultimately, this decision comes down to time. To attend graduate school part-time, especially in physics, often means spreading a 2-year degree over 3 years. The State of Texas limits the time to complete a Ph.D. to 10 years after the completion of the first required course, therefore part-time students often need to work harder to finish their degree before time runs out. Not only do part-time students take fewer classes and miss out on many valuable opportunities such as teaching undergrads, they also often have to work full-time outside of the university. For them, time management is even more critical.

Teaching part-time non-traditional students also requires a significant effort on the part of the faculty. Part-time students tend to miss classes for extremely valid reasons. Fortunately, there are now several new technologies available to record lectures. Working with part-time students in research is also a challenge for many faculty members. As faculty, we often need to push them to make progress and understand that our class or research project is not the most important thing in their lives. This is not an easy thing for a physics professor to accept, but our faculty do try to be flexible.

13.4. Program Student Groups

One of the most valuable resources for a new graduate student is a Physics Club or Society of Physics Students chapter. These groups not only provide great advice on navigating the program, they also tend to be the only people on campus that can help you with your homework. Physics/Astronomy Clubs are local groups which many have no national affiliation. Society of Physics Students (SPS) chapters are local student chapters of the American Physical Society. Either group can provide a much-needed social outlet as well as valuable career advice. UHCL has an SPS Chapter. Sometimes the Physics student's group may have their own lounge complete with a student owned library and coffeemaker. For the UHCL Physics Program, this is STEM 1102 and 1104. This is incredibly valuable and often overlooked by students when choosing a graduate program.

13.5. Computing

Most universities have 2 levels of computing (although only one level is visible to most students). They are academic computing and research computing. Academic computing is always administered at the university level with a centralized service

for managing public computer labs, office computers and university servers (UCT). Research computing may be handled at either the college level or through a specialized high-performance computing (HPC) center. These are computers especially designed for research. While Windows-based PCs and/or Macintosh computers may dominate academic computing, research computing tends to center around Unix or Linux based machines. In the Physics Program, we have a high-performance computing cluster (Singularity) located in STEM 1104 and we have access to the UH system's High-Performance Computing Center.

Upon enrollment, you will receive an academic computing account through UCT. This is pretty much standard procedure for all new students, faculty and employees. Research or super-computing accounts are usually granted only to students when preparing to start research, which requires such access. We have our own computer lab for training students to use HPC and conducting research. Whether you are an experimentalist who needs the computing resources for data analysis or a theorist who needs them to run simulations, this advanced computing has become an invaluable part of physics research infrastructure. Be sure to note to whom you should report computing problems since asking someone in academic computing how to use a supercomputer will most likely result in a very awkward conversation.

13.6. Advanced Lab Facilities

The Advanced Physics lab is located in STEM 1105. The goal of the Advanced Physics Laboratory is for students to learn how to use advanced instrumentation, take and analyze data, model physical systems, and communicate that knowledge. Students should have the opportunity to work on challenging experiments, deepen their understanding of physical systems, and to further develop laboratory, analysis, and communication skills. This lab enables graduate and advanced undergraduate students to be engaged in high-quality research experiences, providing student-centered learning and research opportunities in preparation for transition to a doctoral program or to industry in an R & D environment in line with the mission and strategic direction of UHCL. The equipment housed in the lab focus on the areas of materials science, condensed matter physics, nanotechnology, and biophysics, which are major areas of research that develop new technologies to benefit society. Equipment in this and nearby labs include:

1. Atomic Force Microscope (AFM) capable of providing imaging at the atomic level and evaluate the profile, electrical and mechanical properties of different materials. This AFM is an important interdisciplinary research tool that significantly enhances the learning and publishable research capabilities for both students and faculty.
2. Scanning Electron Microscope (SEM) capable of providing imaging at the nanoscale and determine chemical composition. A focused electron beam interacts with atoms in the sample to provide information on the topography and composition of the

sample. SEM is also an important component in interdisciplinary research especially in materials science and nanotechnology.

3. Condensed Matter equipment package from TeachSpin, a company that specializes in equipment for undergraduate Advanced Physics Labs. This package consists of several high-quality pieces of experimental equipment, allowing students to perform several advanced experiments such as measuring electrical transport, magnetic susceptibility, specific heat and other properties at variable temperatures (80 - 400K) and under vacuum.
4. Chemical Vapor Deposition (CVD) apparatus able to generate thin films under extremely pure, vacuum conditions. Our CVD has been tailored for experiments on growing graphene films and carbon nanotubes.
5. Optical Cryostat capable of reaching very low temperatures around 10K. This can be used for superconductivity experiments, trapping radical molecules at low temperature, and teaching vacuum and cryogenic techniques.
6. Pulsed Nd:YAG Laser for laser ablation to generate small molecular clusters, and unusual radical species and materials.
7. Near Infrared (NIR) Spectrometer to detect light emission and absorption in the NIR, such as the fluorescence of carbon nanotubes.
8. Observational Astronomy Telescope Package for imaging celestial objects, measuring distances to star clusters, analyzing variable stars, modeling sunspot development.

13.7. Summer Schools and Outside Courses

Some sub-fields occasionally offer summer schools that teach more advanced courses than those typically offered at the university. These are highly specialized courses focusing on advanced topics in cutting-edge research. Your advisor may recommend that you attend one of these and may be able to pay for at least part of your expenses from a research grant. They may last anywhere from one week to a full month and could take place anywhere in the world. News of these summer schools comes from professional mailing lists in the field.

Attending a summer school may be a very valuable experience for your career development. You will get to meet and talk to top researchers in your field, when they lecture at the school. You will also have the opportunity to interact with many of your peers from around the world. Because these people are in your field, consider them potential future collaborators (or competition) as you advance in your research career.

13.8. Colloquia, Seminars and Lecture Series

An important but often overlooked part of any physics department is the Colloquia. This is often called a speaker or seminar series. These are probably the easiest part of a physics graduate student's education; you simply need to show up and occasionally ask questions. The value of the colloquia is that it: 1) introduces students to potential career options, 2) teaches students how to give talks by watching others, 3) gives students a chance to meet researchers who may not be at their university and 4) gives students a chance to ask questions about cutting edge research. At UHCL, the physics colloquia are given in combination with PHYS 6837 and 6838 (Research Project Seminar I & II) every fall and spring. Attendance is not limited to students taking the course and is encouraged for all graduate students.