PHYSICS GRADUATE PROGRAM

SMU – DALLAS, TX

STUDENT HANDBOOK

2022-2023

Chair: Professor David Son | Graduate Director: Fred Olness |Revised: August 2022

About this Handbook

This handbook is an informal compilation of information that the SMU Physics Department Graduate Committee hopes will be useful for our graduate students, especially those in their first year. See the SMU Graduate Programs Catalog, available online at https://catalog.smu.edu/, for official general information about graduate programs at SMU. Also, please let a member of the Graduate Committee know if any of the information here is out-of-date or incorrect or if there is additional information you think it should include. We update this on a rolling basis, as required, with scheduled revisions each summer.

Statement of Mutual Expectations

(Approved by the Physics Faculty on 24 Nov 2020; revised 22 Oct 2020)

What graduate students and faculty should expect from our program.

TIMELINE:

- **End of Year 1:** Students should receive a clear indication (from grades and CPE exam results) of their trajectory in our program. Students who continue into Year 2 should be those who we strongly expect will either a) complete an M.S. degree at the end of Year 2, or b) will continue to a successful Ph.D. degree. If a student is unlikely to achieve an M.S. or Ph.D. degree, this message should be communicated consistently, objectively, and promptly through course grades and CPE exam results.
- **End of Year 2:** Our goal for students is to either exit with an M.S. degree or proceed to Ph.D. and begin research. Qualifying requirements should be completed by this time so students can focus on research. Extension of qualifying requirements impedes research progress and delays graduation.

CORE COURSES:

- **Scope & Frequency:** Core courses should be taught frequently and cover the core material common to all physics sub-disciplines.
- **Syllabus:** Core courses should reliably follow a syllabus agreed upon by the Graduate Committee.
- **Evaluation:** Core courses should provide the students regular feedback and timely assessments of their work. Homework should be assigned frequently, graded, and returned promptly with solutions so the students can learn from their mistakes. Exams, at minimum, include a midterm and a final scheduled at the beginning of the semester in accordance with University policies. Elective courses may employ alternative evaluation procedures but should still provide timely and regular feedback on performance.
- **Feedback:** Students are entitled to receive non-quantitative, informative feedback on their course performance from the instructor either at the student's request, via a meeting with the instructor, or on a regular timeline of meetings set by the instructor.
- **Supervision:** Core courses are supervised by members of the Grad Committee, and committee members should visit each class regularly.
- **Relation to undergraduate courses:** Material is taught at a graduate level but builds upon undergraduate material. If review or remedial help is needed for students, guidance should be provided on an individual basis on how best this can be achieved. While undergraduate material cannot be re-taught at the expense of new material, resources should be available for independent study.

- **Grades:** A grade of "B" or better implies the student is performing at an appropriate level for a graduate student and is progressing well toward the Ph.D. degree.

CORE PROFICIENCY EXAM (CPE):

- **Goal:** The goal of the CPE is to establish that the student has mastered the fundamental core topics at an undergraduate level to serve as a foundation for advanced studies.
- **Scope & Level:** The scope of the exam should be well defined, so the students know what to review, and the difficulty level should be stable from year to year, so the student outcome is independent of exam variations.
- **Relation to Core Courses:** The subject material of the exam overlaps with the core courses, but the exam is at an undergraduate level whereas the courses are at a graduate level; thus, a student who masters the graduate level material should be capable of mastering the lower level material.
- **Learning Experience I:** In addition to evaluating the student's preparation for conducting competitive research, the exam and its practice test are intended as an opportunity for students to identify weak points in their undergraduate physics knowledge and strengthen these foundations. Thus, it should not appear insurmountable or fluctuating to a typical student.
- **Learning Experience II:** The CPE is an opportunity for students to assess their mastery of the required undergraduate background for success in the graduate program. It is not intended to eliminate a number of students from the program routinely. All students are expected to pass the exam after the allowed number of attempts if sufficient effort is put forth. Students may request faculty support in preparing for the exam and any subsequent attempts. Faculty expect the students to put in adequate effort and preparation needed to pass the CPE.

CANDIDACY AND PH.D.:

- Graduate students are part of our scholarly community and will be treated with professionalism as junior colleagues.
    - Graduate students are encouraged to pursue research projects pertaining to their thesis or dissertation work, including those independently conceived.
    - Graduate students should receive credit and recognition for their intellectual and research contributions. This includes authorship in publications appropriate to the level of contribution, credit, and recognition for curriculum developed by the student and credit for intellectual ideas.
    - Graduate students are welcome and encouraged to participate in scientific departmental discussions, Q&A sessions at seminars, and academic debates. Their opinions will be listened to and regarded as valid and valuable contributions.
- Graduate students are entitled to respectful mentorship.

  - The thesis advisor will arrange for the graduate student to meet with their Ph.D. committee at least once per academic year to review the student's progress towards a Ph.D.
  - Such meetings can be more frequent upon the request of the graduate student.
  - The Ph.D. committee will make evaluations of the student's progress towards the degree.
  - These evaluations should be factual and specific and should be shared with the graduate student within a reasonable period of time.
  - Students should be notified of any deficiencies in their academic performance in a timely manner and be given specific recommendations and requirements needed to correct their deficiencies before being dismissed from the Ph.D. program.
  - Graduate students can change their academic adviser if necessary. However, any intent to discontinue an advisor/chair/mentorship with a graduate student should be preceded by notice within a reasonable amount of time.
  - Graduate students are entitled to a mentor, peer, or senior, in addition to their advisor.
- Graduate students will be held to reasonable expectations that support the pursuit of the Ph.D. and are not subject to excessive demands.
  - Graduate students can refuse activities unrelated to academic pursuit or professional development and may request a rationale for all assigned tasks.
  - Graduate students can expect reasonable work hours. However, advisors and committee members expect graduate students to spend reliable and consistent time pursuing research on a weekly basis and should be informed in a timely manner of any upcoming vacations or expected absence from work by the student.
  - Graduate students should have access to professional development activities including, but not limited to, attendance of department colloquium and seminars, information on membership in professional associations, opportunities to present their research at conferences, and opportunities to meet with visiting speakers and scholars. Students are expected to avail themselves of these opportunities actively.

Information for New Students

BEFORE YOU ARRIVE AT SMU

- You should receive a letter with your 8-digit SMU ID number in the mail, along with your SMU email address. If you do not, you may pick up a copy from the Department Administrator on arrival. This letter contains information for setting a university password to use your email and log into https://my.smu.edu (my.SMU). You will use my.SMU for a variety of tasks, including searching the course catalog, registering for courses, and maintaining your personal records.
- Submit a photograph for your SMU Identification (I.D.) card to https://idcard.smu.edu. Use your I.D. number and password to log in.
- You might want to sign up for a Dallas Area Rapid Transit (DART) pass before arriving; see the next section of this document for more information. It can take a couple of weeks to be approved, so it could be ready for use on arrival by signing up in advance. However, you will need to wait until after the first week of August and register for classes first, which you can also do in advance.
- The core proficiency exam ("qualifying exam") is scheduled for January of each year. We recommend you review past exams and inquire about how to assess your current readiness for the exam. For information on the exam dates, content, and previous tests, see www.physics.smu.edu/web/grad/quals.
- Let our Department Administrator or someone on the graduate committee know when you plan to arrive at SMU.

ONCE YOU ARRIVE AT SMU

The Physics Department is located in Fondren Science Building (FOSC) at 3215 Daniel Avenue, Dallas, TX, 75205. The Department Main Office is in Room 102. See the campus map: https://sites.smu.edu/apps/campus-map.

On arrival to the Department:

- Introduce yourself to our Director of Graduate Studies and to our Physics Department Administrators (Main Office, FOSC 102). Confirm with the Dept. Admins that your signed [electronic] Payroll Authorization Form (ePAF) was submitted electronically to SMU. Also, pick up your I.D. and password if you did not receive these in the mail. Finally, International Students should have received a DocuSign request through your SMU email to electronically sign an On-Campus Work Eligibility Form, which is required to be attached to your ePAF.

- Check with the Department Administrators that you are signed up for the Annual Teaching Assistant Seminar, which takes place during the week or two before classes

start (usually, but not always, the Friday just before). If not, register at www.smu.edu/Provost/CTE/Programs/TA_Training, where you can also find a program schedule.

- International students must attend an additional training session at the end of the T.A. Seminar. While there, if your first language is not English, you should sign up for ESL 6001, a noncredit English seminar for T.A.s that is very helpful for the majority of international students. See www.smu.edu/Dedman/Resources/Students/ESL/Programs/ITASeminar6001and6002 for information on the course, including an online application form. Our students' experience with this course has been positive. It helps students to build the essential command of English for teaching and research. The most current information regarding the ever-changing requirements for international scholars can be found here: https://www.smu.edu/EnrollmentServices/international.

- Orientation for incoming students will be held online on SMU's Canvas learning management system. Modules about university resources and requirements for new students will be available to incoming graduate students starting Monday, August 10. Please see www.smu.edu/graduate/CurrentStudents/Orientation for details and a schedule.

- International students have a checklist of requirements provided by the International Student and Scholar Services (ISSS) office. Please see www.smu.edu/international/isss/Students/NewStudentInformation for more information.

- All students should check in with the Human Resources office at Expressway Tower, an office building at the intersection of US-75 and SMU Boulevard. Their usual hours are 8:30 AM - 5 PM, Mon to Fri. There you can complete your I-9 employment form. See www.smu.edu/BusinessFinance/HR/Resources/NewEmployeeResources/NewEmployeeChecklist for documents you can use for your I-9. International students will need to complete their document check-in at ISSS first. Check with our Admin that your signed ePAF and, for International Students, your signed Campus Work Eligibility Form were submitted by our Dept Admin before heading over (see above).

- Visit Parking and ID Card Services (located in the Hughes-Trigg Student Center) to pick up your I.D. card and register for parking if you have a car you wish to park on campus. (Parking stickers were discontinued as of August 2019.) Their hours are the same as Human Resources and may be extended on some days just before the start of the semester. See Sec. 19 and www.smu.edu/parkingid for hours and more information.

- The university requires that you set up Direct Deposit to a bank account to be paid. You can now do this yourself from your my.smu.edu account. See www.smu.edu/BusinessFinance/OfficeOfBudgetAndFinance/Payroll/InformationAndFAQs/DirectDepositofPaycheck for more information.

- Sign up for your courses at my.SMU.edu. See page 10 for more information and confirm your schedule with the Graduate Director. You will typically sign up for three three-unit courses. International students should also sign up for ESL 6001.

- After enrolling in classes, you can sign up for a Dallas Area Rapid Transit (DART) pass at the DART Transit Pass Site at Parking Services. After a one-time $5.00 fee, it is free every year for SMU students and allows you to use all DART buses and trains in the Dallas area. It comes in smartphone app or plastic card versions. (Note that Bus 768 provides service between the main campus, Expressway Tower (east campus), and Mockingbird train station and is free for everyone, even without a pass.) You will be notified by email when your pass is ready; apparently, this can take a couple of weeks. After that, you can pick up the plastic card at Parking and ID Card Services in Expressway Tower.

- PerunaNet is SMU's secure wireless network, available throughout most of the campus, including (most of) FOSC. You may connect your laptop, smartphone, or other wireless device using your SMU ID and university password; see www.smu.edu/OIT/Services/Wireless. If you have trouble connecting, you can also use the unsecured guest network SMUGuest.

DEPARTMENT ROUTINES

Weekly Department Seminar/Colloquium: The Department has a single, regular seminar/colloquium weekly on Monday, 4 PM-5 PM. Coffee and snacks are served in FOSC 16 before the talk at 3:30 PM. Please see the department event calendar for details: https://www.physics.smu.edu/web/seminars/. All graduate students are required to attend the weekly Monday speaker series events. Additional seminars are sometimes scheduled during the semester to accommodate special guests or circumstances. These special seminars will be announced as they are scheduled and also must be attended.

Hbar Coffee Bar: Since Fall of 2018, the Department has run a casual coffee and tea hour every week. It is on Wednesdays from 2:30–3:30 PM in FOSC 16. Drop in, grab something to drink and some snacks, catch up with faculty, staff, and other students, and take a break from the day. Weekly reminder emails are sent to invite department persons.

Weekly Department Lunch: During the semester, Fridays at noon are reserved for a Department Lunch at the Umphrey-Lee Student Center (the main cafeteria on campus). This is a chance to unwind at the end of the week, catch up with faculty and staff, and discuss issues, problems, and topics of common interest to all in the department.

Department and Graduate Program Information

CURRENT DEPARTMENT PERSONNEL

Department Chair	Prof. David Son
Department Administrators	Benisha Young, Academic Operations Michele Hill, Research Operations
Associate Chair for Graduate Studies and Director of Graduate Studies in Physics	Prof. Fred Olness
Graduate Student Association Representative	

For the full directory, see www.physics.smu.edu/web/people/.

GRADUATE-RELATED DEPARTMENT COMMITTEES

The graduate committee, composed of a number of faculty, is the primary body for developing and administering policies applying to the graduate program. The committee's membership is:

- Fred Olness (Chair)
- Jodi Cooley
- Bob Kehoe
- Krista Smith

The Graduate Committee is charged with supervising the graduate program, including course content and sequencing, student life issues, qualification exam procedures and administration, graduate recruitment and application review, and other related activities.

GRADUATE STUDENT ASSOCIATION (GSA)

The Graduate Student Assembly (GSA) offers funds to help with research-related expenses. These include but are not limited to travel, lodging, registration fees, and printing materials. To apply for GSA funding, contact your Physics Department GSA Representative and fill out the appropriate forms located at www.smu.edu/graduate/CurrentStudents/GSA.

EMAIL AND OTHER ACCOUNTS

University and Department Email SMU email accounts will be set up by the university once you are assigned your 8-digit SMU ID. This email account will be provided by the university and will look like USERID@smu.edu, where USERID is assigned by the Office of Information Technology. All university correspondence should be done through your SMU email address.

Physics Department Computers All requests for support or assistance in department computing should be directed to the Department Chair.

If you need a computer for work and do not have one, please contact the Director of Graduate Studies and Department Chair to inquire about obtaining a university-provided machine.

(You may also see addresses such as userid@physics.smu.edu or userid@mail.physics.smu.edu in use in the department. These are aliases for USERID@smu.edu and exist for historical reasons; Physics used to run its own email server.)

Once you begin research, you may also request access to the SMU High-Performance Computing (SMUHPC) System, ManeFrame II, for your work. This involves a different account set up by the SMUHPC Administrator. Speak to the Department Chair for more information.

External Resources We have a collaborative documentation site (a "wiki") hosted on an external server. If you want access to this material (which includes helpful information for setting up printers, etc.), please visit astrohep.org/smu/dokuwiki/ and register for an account. The administrator will receive an email when you submit your registration and, based on how soon they can act, you will have permission to access the site within about 24 hours.

Offices, Keys, and Building Access You will be assigned a desk in a shared graduate office before or shortly after your arrival. As soon as you know your office number, ask the Department Admin to request a key. Once the request is processed, which may take a few days, you may pick up your key at the Building Access Office in the Dawson Service Center. The doors to Fondren Science are often locked late at night, on Sundays and holidays, but you can enter using your SMU ID card. Ask the Department Admin to add your I.D. to the list authorizing after-hours access.

Kitchens, tea, and coffee FOSC 16 hosts the Hyer Ed Café, the primary kitchen space for graduate students. This is home to café tables, a sink, food storage areas, a refrigerator, an espresso machine, a drip coffee machine, and a water boiler for tea. The Department will provide tea bags and basic coffee. Students need to provide anything else they wish to use there. A Coffee Club is in operation, with rules posted in FOSC 16. You need only pay into the club (at very reduced prices compared to on-campus eateries) if you utilize department-provided coffee and tea.

There are department kitchens for your use with refrigerators and microwaves in FOSC 38A, 103, and 206. There is also a kettle as well as steeping-ready hot water from the tap in FOSC 206 for making tea. There are also multiple Keurig single-cup coffee machines available in FOSC 38, 103, and 206, for which you must provide your own Keurig K-cups. These can be ordered in bulk, for about $0.30-$0.50 per cup, from either the Keurig company website or Amazon.com, for example, or purchased for slightly more from grocery stores. Refillable K-cups can also be found on the web. The faculty who use these may have other sources to recommend.

Graduate Student Library FOSC 38A serves as a de facto graduate student library and is designated, in honor of Prof. Kent Hornbostel (former colleague and Director of Graduate Studies), as the Hornbostel Graduate Library. This space is equipped with modern video conferencing equipment and is now in high demand for meetings. If you wish to reserve the space, please speak to Lacey Breaux.

FOSC 38A is next to a kitchen and includes a large table and small whiteboard intended to provide a place for people to work together. It also contains the Graduate Library, a growing collection of texts and references for graduate student use, including most course texts and some qual prep books. Please keep these books and journals in the room. Let the department librarian know if there are other publications you would find useful.

Photocopiers and Printers The main department photocopier is in FOSC 103. Your SMU ID card will grant you access to this equipment. Combination printer/fax/copiers are in rooms 38A, 103, and 202. See the department wiki for information about setting up printers.

CORE PROFICIENCY EXAM

Note: The Ph.D. degree requirements in the SMU Graduate Catalog always supersede what is written here. Follow the Graduate Catalog if it at all conflicts with this section, and request an update of this section.

In order to advance to Ph.D. candidacy, SMU requires students to pass a comprehensive core proficiency exam before their fourth semester in the Ph.D. program. In Physics, this takes the form of a four-part written exam at the advanced-undergraduate level. Topics include Mechanics, Quantum Mechanics, Electrodynamics, and Statistical Mechanics. The exam is intended to determine the academic fitness of students to pursue a Ph.D. and to encourage them to review and consolidate their knowledge of basic physics before proceeding to research. Exams are given at least annually. Consult the website below, and the Director of Graduate Studies, for details. Students are allowed two attempts to pass each of the four sections. Details about exam policies, guidelines for the specific exams, and copies of previous exams can be found at www.physics.smu.edu/web/grad/quals. The SMU Graduate Catalog also outlines general university-wide requirements.

COURSE REGISTRATION AND CREDIT-HOUR REQUIREMENTS

Note: The Ph.D. degree requirements in the SMU Graduate Catalog always supersede what is written here. Follow the Graduate Catalog if it at all conflicts with this section, and request an update of this section.

Official course requirements for a Physics Ph.D. include 10 specified core courses, 2 elective graduate courses in physics, and at least 48 hours (or units) of graduate courses in total. Students typically take the core sequence of courses discussed in the next section during their first two years. In addition, they may take electives during their second year, and sometimes beyond that, according to their interests and in consultation with their research

advisor. These may be in physics or related fields, such as math, statistics, engineering, and computer science.

Students may also transfer in as many as 24 hours of graduate-level courses. Please discuss courses you wish to transfer in with the Graduate Director to determine how to obtain credit and whether these should replace courses in our core curriculum.

After completing core courses and electives, students typically sign up for 8000-level research courses in their advisor's name until reaching the required 48 hours. Until then, students must enroll in at least 9 units during the academic year to maintain their status as full-time students. Maintaining your status is crucially important for international students, who may have to leave the U.S. if they do not. After reaching 48 hours, students should maintain their status by registering for the zero-unit course Phys 8049 (Graduate Full-Time Status) until graduation (plus an additional one-unit course; see below).

To satisfy the federal government, students must enroll for at least one unit every semester while at SMU. This is required for students to maintain their SMU health insurance and prevents social security taxes from being taken out of their pay. This includes students enrolled in PHYS 8049. The department offers some one-unit courses to facilitate this, such as the PHYS 8100 Research course.

It is extremely important for all students to register for each semester; apparently, this can be easy to forget once research begins full-time. This is particularly true for international students, for whom failure to register can result in the loss of visa status, and in some cases, expulsion from the U.S.

Finally, note that the university requires graduate students to maintain a B average.

CORE COURSE SEQUENCE

The department offers a set of ten reliably scheduled courses with an emphasis on particle physics, including Classical Mechanics (6321), Electrodynamics (7311 and 7312), Quantum Mechanics (6335 and 6336), Statistical Mechanics (6351), Introductory Particle Physics (5395), Experimental Particle Physics (7363) or a recommended substitute, and Quantum Field Theory (7314 and 7315), as well as several elective courses. The core sequence runs on a two-year cycle, with some courses offered only in alternate years, as illustrated in the table below. Students entering in even years follow the first sequence, odd years follow the second.

You are required to take at least 8 of the 10 courses designated as "core." For example, students intending to focus on particle physics (theory or experiment) might prefer to take a portfolio like PHYS 6321, 6335, 6336, 6351, 6380, 7311, 7312, 7314, 7315, 7363. Students intending to focus on astronomy/astrophysics might prefer to take a portfolio that only includes PHYS 6321, 6335, 6336, 6351, 6380, 7311, 7312, 7363 and use two other graduate-level courses (e.g. in cosmology, stellar, or galactic astrophysics) to fill in the remaining two courses that Quantum Field Theory would have used.

Any remaining courses of the required minimum 12 can be satisfied using "Non-Core" physics graduate courses in what follows, whereas all core + fixed elective courses we refer to as our "core sequence."

The table below is a practical guide to the department graduate core course sequence. Non-core courses must also be taken to fulfill the total credit-hour requirements of the graduate program. Class slots marked "Non-Core" can be filled using classes within the physics program that meet graduate course credit requirements, such as Computational Physics, Mathematical Methods, Research, or other courses. These can also be graduate-level courses in related departments, such as Statistical Sciences.

	The Fall Term Begins in an…			
	Even-Numbered Year		*Odd-Numbered Year*	
	Fall	**Spring**	**Fall**	**Spring**
First-Year Students Take…	**6335:** QM I **7311:** EM I **Non-Core**	**6336:** QM II **7312:** EM II **6321:** Classical Mechanics	**6335:** QM I **6351:** Stat. Mech. **Non-Core**	**6336:** QM II **7363:** Exp. Particle Physics **6321:** Classical Mechanics
Second-Year Students Take…	**7311:** EM I **7314:** QFT I **Non-Core**	**7312:** EM II **7315:** QFT II **Non-Core**	**7314:** QFT I **6351:** Stat. Mech. **Non-Core**	**7315:** QFT II **7363:** Exp. Particle Physics **Non-Core**

Specific information about the courses should be obtained from the SMU Course Catalog, which is the official repository of all such information: catalog.smu.edu.

NON-CORE COURSE OPTIONS

Some basic information about possible Non-Core Course options is given below.

- PHYS 7305 (3). METHODS OF THEORETICAL PHYSICS. Mathematical methods; theory of analytic functions, evaluation of integrals, linear vector spaces, special functions, integral equations, tensor analysis, calculus of variations, group theory.
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- PHYS 7360 (3). Elementary Particles I. Physics of the standard model; quarks and leptons; internal symmetries, grand unified theories. This may be used as a substitute for PHYS 7314 if that course is not offered, and this one is.
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- PHYS 7361 (3). Elementary Particles II. Continues PHYS 7360 with emphasis on current topics. This may be used as a substitute for PHYS 7315 if that course is not offered, and this one is.

- PHYS 3340/6361 (3). COMPUTATIONAL PHYSICS. Introduction to the modeling of physical systems. Emphasis is on algorithm selection and implementation for simulating classical and quantum physics.

- PHYS 5337 (3). INTRODUCTION TO SOLID STATE PHYSICS. Crystal lattices and the reciprocal lattice, the free-electron model of metals, crystal binding, lattice vibrations phonons, thermal properties of solids, and energy bands in solids.

- PHYS 6338 (3). CONDENSED MATTER PHYSICS. Plasmons, polaritons, and polarons. Optical properties of solids. Superconductivity. Atomic and collective magnetism. Atomic and collective electrical phenomena.

- PHYS 6368 (3). FOUNDATIONS OF MODERN COSMOLOGY. Principles and concepts of modern cosmology including the geometry of the universe, cosmological models, nucleosynthesis, inflation, dark energy, dark matter, the cosmic microwave background and baryonic acoustic oscillations.

- PHYS 6371 (3). STELLAR STRUCTURE AND EVOLUTION. An introduction to the basic physics of stars, including energy generation and transport, equilibrium and instability. Includes observational sources, nuclear processes and star formation, evolution and death. Prerequisite: Permission of the instructor.

- PHYS 6372 (3). GALACTIC STRUCTURE, DYNAMICS, AND EVOLUTION. Advanced study of galaxy classification, structure, and evolution. Includes processes inside galaxies, such as star formation, motions of gas and stars, and the role of central black holes.

Recommended Non-Physics Courses

Graduate-level classes in other departments can fulfill your remaining elective courses. Other departments at SMU offer the courses in this section and, in many cases, have been taken by our graduate students to expand their knowledge and build expertise in areas related to our research: mathematics, statistics, and computation.

- MATH 6370 (3). PARALLEL SCIENTIFIC COMPUTING. An introduction to parallel computing in the context of scientific computation.
- STAT 6327 (3). MATHEMATICAL STATISTICS. Theory of probability distributions. Random variables and functions of random variables. Multivariate and conditional distributions. Sampling distributions; order statistics. Expected value, transformations, and approximations.
- STAT 6328 (3). MATHEMATICAL STATISTICS. Sufficiency and completeness. Unbiased, maximum likelihood and Bayes point estimators, minimizing risk. Confidence sets. Most powerful, uniformly M.P. and likelihood ratio tests. Large-sample approximations; contingency table analysis.

- STAT 6336 (3). STATISTICAL ANALYSIS. Emphasis on application of statistical principles in the design of experiments. Complete and fractional factorials, blocking, nesting, replication, randomization. Analysis of data from one and two samples assuming normal distributions and independent errors. Discussion of paired sample analyses and of nonparametric location tests.
- STAT 6337 (3). STATISTICAL ANALYSIS. Analysis of data from classical multifactor experimental designs with fixed and random effects. Multiple comparisons and contrasts of main effects and interactions. Introduction to regression analysis.

FINANCIAL SUPPORT

Prior to admission to candidacy, most Ph.D. students will receive their assistantship for work as Teaching Assistants (T.A.s), assisting faculty in lecture or lab courses. Assignments are made shortly before each semester. T.A.s may work up to 20 hours per week during the semester, though 15 hours is more typical. Support is only guaranteed during the fall and spring semesters, though most students who wish can find T.A. or research work during the summer.

Ideally, soon after admission to candidacy, students will transition to Research Assistant (RA) support working as part of an externally-funded research group, as discussed in Sect. 13. T.A. positions are often available for students whose advisors are unable to provide R.A. support.

Tuition and fee aid/support is provided by the department for Ph.D. candidates. Do not be surprised to see such charges on your student account, as it takes time to process and pay these charges. However, if such charges remain for a long time on your student account, please see the department administrator for assistance. SMU does not allow tuition waivers for M.S. candidates.

Several students in our program have received support from external, prestigious national fellowship programs (e.g., the Department of Energy Office of Science Graduate Student Research, or SC-GSR, program). They did so by applying while guided by a faculty mentor. We strongly encourage you, if you have an interest in being supported by such a program, to identify a research mentor as soon as possible and work with them to apply for support. Many such competitive external programs are offered by the National Science Foundation, Department of Energy, the Hertz Foundation, the Ford Foundation, etc. They often impose time restrictions on applications, so investigate early and often!

PH.D. RESEARCH

Students who pass the core proficiency exam must then establish a Ph.D. research advisor in consultation with that person. A Ph.D. committee consisting of two additional faculty must also be established by the beginning of the fifth semester. This process should proceed in consultation with the research advisor and the Director of Graduate Studies, who can assist in the identification of committee members and ensure workload-balancing amongst faculty members. Committee members are usually drawn from within Physics, though

faculty from related programs are also eligible. The Ph.D. advisor and committee guide research and preparation of a thesis. In the last year of the Ph.D. process, a final member must be added to the Ph.D. committee and must be a faculty member from outside the department (an external member). The research advisor, two faculty from within the department, and one external member will conduct the Ph.D. defense.

University guidelines state that students should complete and defend their dissertations within five years after being admitted to candidacy, that is, after passing their core proficiency exam. The Dean can extend this by one year.

The following is a rough outline for the process you will follow to select a research topic, find an advisor, and form a committee.

1. During the first two years, you will be mainly occupied with courses and T.A. duties, but you should also use this time to learn about research opportunities within the department. Methods include attending seminars and department lunches, talking with more senior grad students and postdocs, sitting in on research group meetings, but mainly by talking with faculty. It is a small department, and faculty are usually happy to discuss their work, but it's important for you to take the initiative; it is ultimately up to you to decide what you would like to work on.

2. It is beneficial to arrange with one or possibly two faculty members to work on research during the summer after your first year. (Although you may wait until the third year to formally choose an advisor, it's usually a good idea to begin as early as possible to work with someone on a trial basis; you may change later if you choose.) Some faculty may have funds to support you during the summer, but T.A. positions are also available. The Graduate Director or Chair can give you information. You should make arrangements for your summer by the middle of your second semester at the latest.

3. You should select, by mutual consent, an advisor who is willing to guide your dissertation research and has external funds to support your work. Having had some prior research experience together, as discussed above, will help a great deal here.

4. Ideally, your advisor will have adequate funds to support you as a Research Associate (RA) until completing your dissertation, but it is unlikely that all students can be supported fully on R.A.s. During semesters when an advisor is unable to provide support, it is possible that a T.A. position or other sources of funds, such as university dissertation fellowships, will be available. The Chair and Graduate Director will work with you and your advisor to help, but it is important to know that entrance to candidacy does not guarantee support through to completion of your degree. If you are having trouble finding an advisor by the end of your fourth semester, discuss this with the Graduate Director or Chair.

5. In consultation with your advisor and the Graduate Director, select two additional department members to serve on your thesis committee. Our intention is that, in

addition to participating in your thesis defense, committee members will monitor your progress from an early stage, will be available as sources of collaboration, information and guidance, and a valuable source of recommendation letters if you choose.

6. Shortly after forming your core Ph.D. committee, you will present to it a proposal for your Ph.D. work along with a short, formal presentation open to the department. The proposal and presentation will allow you to communicate to your committee basic information about your area of research, the importance of your research subject, your goals, how you will achieve those goals, and to receive feedback. Thereafter, you will meet with your committee no less than once a year to review progress, which the committee chair will report to the department.

7. In order to continue in the program, you must complete this proposal and presentation to the satisfaction of your committee no later than the end of your sixth semester.

8. Early in the semester in which you hope to graduate, inform the Graduate Director, who will then give your name to the Graduate Studies Office. If you are unsure whether you will finish that semester, it's better to get on the list; you can defer later if you need to. Once the Office has your name, you will be able to apply for graduation at my.smu.edu. You will need to keep track of various other forms to submit and deadlines to meet. Please read through the information at www.smu.edu/graduate/CurrentStudents/Graduation and pay particular attention to the information at the timeline link.

9. When your dissertation is nearing completion (the last year of your Ph.D. candidacy), you and your advisor will schedule a thesis defense in coordination with your committee. Your advisor will also arrange for a final external committee member, usually chosen from another appropriate department from within SMU, though a member from outside is also possible (this requires approval from the Dean, so please speak with your advisor about this if you choose to pursue this option). Your thesis should be delivered to the committee no fewer than 30 days before the scheduled defense. Your defense will consist of a public and open presentation, typically about an hour long, and which includes questions by the committee, followed by a closed session with the committee. A typical thesis defense lasts about 90-120 minutes. The committee then conducts private deliberations and renders a decision on your defense. After the defense, the committee should submit a report to the Graduate Studies Office.

MANDATORY TRAINING

Within the first semester that you receive R.A. support, you must complete an online training program on the Responsible Conduct of Research. See www.smu.edu/graduate/CurrentStudents for information and a link to access it. You can spread the training out over several hours.

Students are also required to enroll in a 1-unit course entitled "Physics Teaching Practicum." This will provide instruction and feedback, as well as mentoring, in becoming a better teacher in the undergraduate introductory physics course environment. It complements your assigned duties as a T.A. The course number as of 2018 is PHYS 6160.

HEALTH INSURANCE

SMU requires all full-time students to carry health insurance and offers the Student Health Insurance Plan (SHIP). Students must explicitly waive or enroll in the SHIP each semester. If you take no explicit action, you will be automatically enrolled. It is far better to enroll early than to wait until the deadline passes and then be automatically enrolled, so please act as soon as you can to enroll in this program. You then have 30 days to cancel the insurance. The insurance premium will appear on your student account. Financial aid for their insurance, which comes from the Moody School of Graduate and Advanced Studies for the first five years of enrollment and from the Physics Department beginning the sixth year of enrollment onward, will also post to your account. You will receive an insurance card in the mail. SHIP does not cover dental health — that is an additional expense that the Department or the College does not cover.

You may enroll annually using my.SMU.edu after you have registered for classes. You also have an option to enroll members of your immediate family each semester.

If you already have coverage, you may choose to waive SHIP. See www.smu.edu/StudentAffairs/HealthCenter/Insurance for more detailed information. The Physics Department administrative staff does not have access to health insurance information beyond seeing what posts to students' tuition and fees accounts. SHIP inquiries may be submitted to the SMU Insurance Office at the Student Health Center at studenthealthinsurance@smu.edu or (214) 768-3408.

HEALTH AND FITNESS

SMU offers free membership in the Dedman Center for Lifetime Sports for both undergraduate and graduate students. The center has basketball courts, an indoor swimming pool, a climbing wall, a boulder wall, and an array of modern fitness equipment for cardio and weightlifting. It is located on the southeast corner of campus. Spending time here is a great way to relieve stress. More information can be found at www.smu.edu/StudentAffairs/RecSports.

University and Employment Information

CAMPUS MAP

A map of the campus can be found at sites.smu.edu/apps/campus-map.

SALARY AND DIRECT DEPOSIT INFORMATION

For Direct Deposit instructions, please refer to www.smu.edu/BusinessFinance/OfficeOfBudgetAndFinance/Payroll/InformationAndFAQs/DirectDepositofPaycheck for the latest information.

SMU will deposit your salary and any reimbursement payments for work-related expenses via electronic transfers to your account in a U.S. bank or another financial institution. Direct deposit is the only method by which SMU will disburse your salary. Such disbursements are made every month, and the schedule is available from Lacey Breaux. Please note that the setup for direct deposits of Payroll and Accounts Payable (reimbursements) are separate and require two different forms.

SMU requires every employee to enroll in direct deposit within 90 days of the employee's hire or rehire date. You will need to open a U.S. bank account before setting up direct deposit. International students need to apply for a Social Security Number (SSN) to open a U.S. bank account.

W-4 FORMS FOR THE INTERNAL REVENUE SERVICE

At the end of each calendar year, SMU will issue a W-4 form that you will need to submit by April 15 of the next year to the Internal Revenue Service together with your tax declaration form. The "Deductions and Adjustments Worksheet" for your W-4 Form for taxes is available at www.irs.gov/pub/irs-pdf/fw4.pdf. Please note, the Physics Department administrative staff cannot provide advice on filing taxes.

INTERNATIONAL STUDENT AND SCHOLAR SERVICES (ISSS)

The International Student and Scholar Services (ISSS) office provides a variety of services for international students and is located in Blanton Building Suite 216. Their website is www.smu.edu/international/isss. Walk-in hours are Mon to Thurs 9–11 AM and 2–4 PM. (They may have modified hours the week before classes start; check their site.) They have posted an international student handbook at sway.office.com/x9GdICdtmXDDu3HN which may have useful information.

It is VERY IMPORTANT for international students to check-in with ISSS each time they are planning to go abroad in order to have the proper immigration paperwork filed and to be aware of any matters affecting their re-entry into the U.S.

OBTAINING YOUR I-9

Who must complete an I-9? The U.S. Citizenship and Immigration Services requires a Form I-9 to be completed by all SMU employees who are paid wages. New employees hired for regular staff or faculty, student employee, and temporary employee (staff and faculty) positions must complete Form I-9.

When must the form be completed? New employees must come to the Department of Human Resources on the first day of employment to verify eligibility to work in the United States and complete the I-9. A Human Resources representative will be available for completion of this document during the hours of 8:30 AM – 5:00 PM, Monday through Friday.

What are the acceptable documents to complete I-9? New employees should consult the List of Documents Acceptable for Verification of Work Eligibility and Identity prior to the first day of work. The employee will be asked to present either one original document from List A confirming employment eligibility and identity, OR one original document from List B establishing identity AND one original document from List C establishing employment eligibility. The choice of which document(s) to present belongs entirely to the employee. All documents presented must be original and unexpired.

Who must be re-verified? If an employee indicates that he or she is an alien authorized to work until a specified date, then the employee's work authorization must be re-verified on or before the date indicated by the employee. Every month, a list will be generated by the Department of Human Resources containing the names of all employees whose employment authorization will expire within the next 120 days.

H.R. will send a notification to the employee, advising the employee to present an unexpired document of his/her choice from List A or List C evidencing his or her continuing work authorization no later than the date the current work authorization will expire.

Policies and Procedures

Our baseline expectations for your academic performance and professional behavior are outlined in the Graduate Catalog for Dedman College of Humanities and Sciences, with foundational expectations from the College discussed in that document in the chapter entitled "Degree Requirements." In addition, department-level requirements, which may go beyond what the College prescribes, are also outlined in a later chapter of that catalog.

In this section, we describe the processes in place in the department to assess your academics, research, and professionalism. Please familiarize yourself with them, as they will help you to navigate your time here in our program successfully.

Evaluation Timeline: Each year, you will be required to fill out a "self-evaluation form" that provides you the opportunity to assess your progress in the department toward completing your foundational coursework and your progress toward the Ph.D. through your research. This form will be provided to you by the Director of Graduate Studies and is required to be completed and returned to the Director no later than March 15 of each year. If you have given any presentations at professional meetings, published any papers, or conducted any other such professional activities in support of your progress toward the Ph.D., you will be expected to attach a copy of your Curriculum Vitae (CV) to the form. If you are uncertain how to prepare such a document, please speak with the Director of Graduate Studies, who can provide suggestions, guidance, and even examples as needed.

The faculty meet regularly, approximately once every other month during the fall and spring semesters. Your self-evaluation, as well as the evaluation of your performance by your (a) course instructors, (b) instructor overseeing your work as a teaching assistant (if applicable), and (c) your research mentor and Ph.D. committee (if applicable), will be discussed after March 15 at the last faculty meeting of the year.

Based on the outcome of self-assessment and the assessment by your instructors and mentors, you will be provided a summary of your evaluations by the Director of Graduate Studies no later than spring commencement (typically in mid-May of each year). This will provide guidance on your progress in the program and advise you on how to improve your performance.

If serious deficiencies in performance are identified, you will be given until the end of the subsequent academic year to remediate them. This should be enough time to address the classes of issues outlined below. If you are unable to address these issues in the given time, your continuation in the program may not be possible.

Failing the core proficiency exam after your official tries are passed is immediate grounds for termination in our graduate program.

Performance Assessment — Guidance and Expectations: Your performance in the program will be assessed in the following categories, as applicable.

1. **Academics:** While enrolled in SMU courses, you must earn grades that keep you in good standing in our program. Each instructor will outline their expectations for your contributions and performance in their class, and each instructor has the freedom to define such procedures via the syllabus for their course. You are expected to meet or exceed those expectations, so pay close attention to the course requirements. If you feel they are not clearly specified, speak with the instructor outside of class to establish those expectations.

2. In addition, if you are serving as a teaching assistant, you will be supervised by the course instructor. Your supervisor should, at the beginning of each semester, explain what duties are expected from you. If those duties and expectations are not clear, please follow up with the class instructor.

3. **Research:** When you are engaged in research (typically after the first two years, but you may engage in short research projects with faculty prior to formally starting your Ph.D. research), you are expected to set goals for your project(s), make progress toward those goals, document your progress and findings, and assess the findings and goals with each step forward. This is a very broad set of expectations, but each research mentor is different, and you are expected to meet with your research mentor regularly in order to establish expectations, goals, and methods for achieving those goals. As a graduate student, you are expected to take initiative with the guidance of your advisor.

4. Your performance in the research environment will be primarily assessed by your research advisor and check-pointed by your Ph.D. committee.

5. **Professionalism:** In academic research and teaching, you will be assessed based on your professionalism — your ability to act as a reliable colleague in the academic environment according to the established professional standards of the department. While such standards can vary depending on the persons with whom you are interacting (our department is culturally diverse), nonetheless, there are a basic set of standards to which you are expected to adhere.

    a. You are expected to be academically honest. Your work should be your own. You should explicitly acknowledge contributions by others. You are not to use others' work without attribution as your own. Your data should accurately reflect how it was collected and should never be tampered with to change outcomes. We repeat this here because the integrity of work, credit to those who do original work, and the accurate representation of your work are essential to science.

    b. You are expected to be collegial. This means respecting the ideas and work of others, whether you agree with them or not. Above all else, each person has valuable ideas to contribute to the success of our teaching and research. Disagreements can be resolved without anger, rude behavior, or intolerance.

In addition, we often share offices or laboratory space. While our department is small and friendly, it's also important to remember that everyone has important work to perform. Respect other people's work time and privacy, and give them space if they request it. Keep extraneous noise to a minimum, keep your workplace clean and free from food, do not encroach on each other's personal space. Talk to your peers to establish rules to help respect each other's work time and privacy. Speak to the Director of Graduate Studies if there are any unresolved issues.

c. You are expected to be punctual. Time is a precious asset, and it is important to be on time for events that are part of your workday.

d. You are expected to meet or exceed expectations or goals that are set. This has been stressed above in Academics and Research, but in general, in our department, if you agree to do something, then you are expected to complete your end of the agreement. This is also why it is important to understand what is expected in any situation and clarify those expectations, regardless of whether it concerns your coursework, research, or extra-curricular activities (such as helping organize a workshop). Ask the Director of Graduate Studies for advice on this or any other matter related to professionalism.

Conflict Resolution: Conflicts may occur in all settings of human endeavor. Here we outline the procedures for resolving conflicts that may arise, noting that completing the core courses and original scientific research are the main requirements for earning Ph.D. degrees.

1. **Academic Conflicts:** If a student feels that they have not been treated fairly in the classroom setting by an instructor, they should first discuss their concerns with the instructor. If this does not lead to a satisfactory resolution, the student should then discuss their concerns with the Director of Graduate Studies, who will mediate the issue between the student and the instructor. If this fails to resolve the issue, then the student can bring this to the attention of the Department Chair. If the student still feels the issue has not been resolved, they can bring the issue to the attention of the Dean of the College.

2. **Research Conflicts:** Resolution of issues related to research should proceed along the same sequence of steps as with academic conflicts (see above). The vast majority of issues can be resolved through dialogue within the research group and with the student's advisor. Should the situation require the intervention of the Director of Graduate Studies or the Department Chair, both the mentor(s) and the student must proactively explore the steps needed to help the student to complete original research, the core requirement of the Ph.D. program. In such situations, it is appropriate for the student to discuss the goals and timeline for completing the

Ph.D. degree, financial support for the student if switching between the research groups, and any career-related and work-life-related matters.

Any other conflict (such as those regarding issues of professionalism in a shared office) should be addressed by first trying to constructively resolve the matter between those involved in the conflict. If such resolution is not possible, then the issue should be brought to the attention of the research mentor (if it involves personnel within a singular research group or lab), the Director of Graduate Studies (if it involves conflict between graduate students), or the Department Chair (in other situations). Please adhere to the above guidelines so that conflict situations can be identified, documented, and resolved in a structured manner. This is essential to the functioning of any academic department.

University Guidelines: The University has a code of conduct and guidelines on professional behavior. If anything is unclear, please consult the SMU Student Conduct website for detailed information about policies:

www.smu.edu/StudentAffairs/StudentConduct.

City/Region Information

Dallas is a large city with several places to search for housing. A few things to consider:

1. Dallas is one of the largest metropolitan areas in the United States. Just because something is in Dallas does not mean it is close to campus.
2. The SMU campus is surrounded by two small cities, University Park and Highland Park, with high costs of living. Although they are convenient, it may be difficult to find housing that close to campus.
3. Additionally, when searching for housing, it would be recommended to look north of I-30 and south of I-635 to avoid long, traffic-related commutes to and from campus.

More specifically, there are areas to look for housing where the primary residents are young professionals. These areas have been more affordable in the recent past, so you will need to investigate costs carefully as you consider places to live.

- "The Village" is a large collection of apartments approximately 5 minutes from campus. The DART 768 bus runs through parts of this area.
- There are also several apartments located between Mockingbird Lane and Lovers Lane that are readily accessible from campus.
- "Uptown" is a neighborhood approximately 10 minutes south of campus.
- Downtown Dallas has several options and provides access to nightlife and entertainment options within walking distance.

Most importantly, feel free to ask existing graduate students where they live and what housing options they suggest.

TRANSPORTATION

Public Transportation Dallas Area Rapid Transit (DART) bus and rail passes can be purchased at a discounted rate. Additionally, the DART 768 bus is free and runs regularly between Bishop Boulevard on the campus, to Expressway Tower east of I-75, and area apartment complexes and stores.

Commuting by Car If you drive your own car and use tollways or municipal paid parking at the airports and other locations, it is recommended to buy a TollTag (a radio-frequency identification device) to pay the tolls and/or parking fees at a greatly discounted rate. Your toll tag can also be used to automatically open parking gates at SMU, if you buy a parking pass for the campus. More information about toll passes can be found at www.ntta.org.

Airports Love Field Airport is a smaller airport that is close to campus (about 15 minutes away). If coming to visit campus or looking at flights when moving, this is something to consider. This airport hosts many regional flights and is the main hub for less-expensive airlines like Southwest Airlines.

Since most of our research projects involve a component of travel within the United States and across the world, you will also become familiar with the region's major airport: Dallas/Fort Worth International Airport (DFW, for short). By car, DFW Airport is about 45 minutes from campus. You can find dozens of direct flights each day to major airports across the United States and the world.

Public transportation, especially by light rail, is possible to both airports.

OUTDOOR ACTIVITIES

Dallas has several outdoor attractions. The Katy Trail is a cycling/walking path that connects campus to Downtown. White Rock Lake is a small body of water that is surrounded by walking paths and has access to recreational opportunities, including paths and trails and an arboretum. Klyde Warren Park is a green space in Downtown that is constructed atop the Woodall Rogers Expressway. There are also ongoing efforts to improve the Trinity River, south of Downtown Dallas, called the "Trinity River Project." Talk to peers and locals to find other recommended outdoor activities.

SHOPPING

The Dallas Metroplex is filled with areas to shop, both within the city limits and throughout all of the surrounding areas. Of note, there is an IKEA located along the Dallas North Tollway in Frisco, TX. Be sure to speak with fellow students to find the best locations for shopping for clothes, food, furniture, etc.