Welcome to Hopkins! This is the second edition of a handbook written by student members of the JHU Society of Physics Students (our department’s undergraduate club) to tell new physics majors all the things we all wish someone had told us when we were freshmen. All the opinions laid out below are those of SPS alone – they don’t necessarily represent the views of the JHU Physics department. We hope you find this useful!

Chapter 1: The Major
This chapter of our guide will give information about courses that physics majors at Hopkins take. We recommend reading it carefully, since our coursework can get fairly complicated at times.
Note 1: If you haven’t for certain chosen a physics major yet, be sure to read through Section 4.
Note 2: If some of the descriptions in this section look somewhat short, it’s probably because none of the authors took the course in question.

Section 1: Courses in Physics (and when to take them)
One of the greatest defining characteristics of the Physics major at Johns Hopkins is its (mostly) linear organization. You are generally expect to complete a three-year sequence of courses in a specific order, and take electives in your fourth year to specialize. Because of that structure and the small number of students in the major, you’ll see all the same people in each of your classes and never be without others to collaborate with. Assignments for our courses tend to be geared towards group work, and the department supplies us with plenty of open study space. Physics majors at Hopkins struggle together and triumph together.

The above is usually true, but there are some exceptions. Some students with extensive high school preparation choose to skip the first two courses and in essence start the physics track with sophomore year. Some students also skip some lower level courses so they can take courses at the graduate level earlier. Speak with the faculty if you’re interested in either of these things - some students say it could help you get into grad school, while others insist that you’ll perform better following the university-designed curriculum.
You should note that you should expect to see much lower grades in your college physics classes than what you’re used to in high school. Our department is filled with very intelligent individuals, so our exams are accordingly difficult. Half the total number of points is not bad for some of the physics exams you’ll take, and for a few, 30% could mean an A+. Remember that you’re graded on a curve, so your professors may have some fun with you on exams!

Another note: one downside to our linear arrangement of classes is that you have to schedule other classes around your physics courses. Our department really favors the prime time slots – 9am and 11am – so don’t be surprised if you’re blocked from taking an elective you wanted at some point down the line.

Course information below is arranged as follows:
Course number and name
Currently / most recently taught by
When most majors take it
Description and recommendations

Required for the Major:
Below, the courses we’re required to take as physics majors are listed. In addition to these classes in the physics department, we’re required to take or have credit for Calculus I, II, and III, Linear Algebra, and Differential Equations, all of which are described in the ‘Math’ section further down.

171.105 Classical Mechanics I
Daniel Reich
Freshman Fall
This course is designed to introduce you to being a physics major. Depending on the rigor of your high school physics classes, you may be familiar with a lot of material here already, but the math is probably a bit more sophisticated, so don’t underestimate it. You’ll learn about all the standard topics in intro classical mechanics, from energy potentials to oscillations.
Recommendations: This is your first college physics course! The following advice will carry through to all your future classes. First, this isn’t high school; there’s no penalty for missing class. However, we don’t recommend it – you’ll quickly fall behind. You were probably top of your class in science and math in high school, but here, everyone was. Don’t underestimate the work. Homework works a bit differently here, too. You’ll probably have less than a dozen problems per week, but they will be quite lengthy and challenging. You cannot leave them for the night before the due date! Start them early – not because it’s better to get them done early, but because they will often take several
sessions to complete. We recommend working with your classmates on homework, too – this is encouraged, it’s not cheating. Mechanics I is also a great time to meet the classmates you’ll be working with for the next four years. Also, don’t be surprised when your grades on exams are quite a bit lower than what you’re used to - that’s what is expected of you.

173.115 Classical Mechanics Lab
TAs + Chia-Ling Chien
Freshman Fall
This course is a required co-requisite for 171.105. It meets once a week in the evening, and you have to stay for as long as it takes you to complete the lab assignment. The labs are basically the same as those assigned to students taking general physics, so they may be somewhat easy at times, but the class is a good way to get to know the other physics majors with whom you’ll be working for the next four years. Recommendations: Make sure you pick lab partners you’ll work well with! And be sure you can bring a laptop every week – you’ll definitely need it.

171.106 Electricity & Magnetism I
Mark Robbins
Freshman Spring
Even if you took AP Physics C: E&M in high school, this course will probably contain a lot of material you haven’t seen before. Math from Calculus III is everywhere, and this course can get quite challenging sometimes, but you’ll spend a lot of time collaborating with your classmates to solve complicated problems and should get a sense for what upper-level classes might be like. Maxwell’s Equations are the topic of focus. Recommendations: Try to read the book, but don’t spend too much time on every word. Purcell explains things well but can be long-winded. Reading more advanced texts, like Griffiths E&M or online course notes from MIT, can be useful because they often include shorter ‘review’ sections on lower level material. You’ll have a much easier time in this class if you’ve already taken Calculus III (or are taking it at the same time, but you’ll find that new topics tend to show up earlier in this class than they will in Calc).

173.116 E&M Lab
TAs + Morris Swartz
Freshman Spring
This course is simply a continuation of 173.115. We found the E&M labs to be somewhat more interesting than the mechanics labs, though.

171.201 Special Relativity & Waves
Nadia Zakamska
Sophomore Fall
This course is often considered by SPS members to be one of the hardest in the major. It consists of three weeks of special relativity with an exam at the end, followed by ten weeks of waves and oscillations. The concepts, homework assignments, and math content in this course are all especially intense. Both linear algebra and differential equations topics will appear, and most students complete linear algebra before taking this class and take differential equations at the same time. Other combinations are possible, and different SPS members will offer different advice, but regardless of your choice, this class will probably require a nontrivial amount of external study.
Recommendations: The books for this course are not comprehensive. Missing lectures is definitely a bad idea, and extra help with the TAs can prove invaluable.

172.203 Contemporary Physics Seminar
Natalia Drichko
Sophomore Fall
The actual format of this class tends to vary year to year, but it usually consists of one small group of students per week giving a presentation on a current research topic in physics. The course acts as a tour of the field you’ll enter if you become a research physicist.
Recommendations: Just start your presentation a couple of weeks in advance and this course should be no trouble.

171.202 Modern Physics
Chia-Ling Chien
Sophomore Spring
This course is your first full introduction to the world of physics being researched today. Most of it acts like a sort of pre-Quantum Mechanics class, but you’ll also be exposed to various other topics from higher-level physics, possibly including particle physics, statistical physics, condensed matter physics, cosmology, and more. The class takes it easy on math content so that you can really focus on acquiring the conceptual ideas you’ll need in more advanced classes. It’s a great way to decide whether physics is really the subject for you, because you’ll get a taste for all the topics addressed by the field today.
Recommendations: Follow the Krane textbook carefully; what you need to complete the homework may be hidden in there. Don’t be surprised if you need to spend some time with Google to find some additional material not necessarily covered in class or the textbook!
171.204 Classical Mechanics II
Julian Krolik
Sophomore Spring
This course covers Lagrangian Mechanics – a mathematical formulation of classical mechanics that makes complicated kinematics problems much easier. (One old SPS President called the course “It Spins: The Class”.) The course is pretty math-intensive, and will involve lots of differential equations and some linear algebra. Partial differential equations show up sometimes, but you’ll learn all you need to about them from Professor Krolik.
Recommendations: Both the homework and the exams for this course can be long and difficult, but it can be very rewarding to spend extra time with the problems and really think about what the Lagrange Equations imply. Many of us also really liked John Taylor’s textbook.

171.301 Electromagnetic Theory II
Andrei Gritsan
Junior Fall
This course continues the material begun in 171.106. You’ll start with a rapid review of everything covered in that course, with much more emphasis on theory and mathematics this time around. You’ll then move on to more advanced material, with a lot of attention given to wave mechanics and the exact corrections to the E&M fields for moving charges. This course is extremely mathematically rigorous, and also demands a lot of attention. Homework starts off difficult but quickly becomes easier, in our experience.
Recommendations: Read the Griffiths textbook before coming to class. And again after class. Supplementing this class’ very in-depth lectures with sufficient reading will help you stay afloat. For most of us, this was one of the most difficult courses in the major, so be prepared!

171.303 Quantum Mechanics I
Chia-Ling Chien
Junior Fall
This is the big one- you're finally learning QM! This course covers the full versions of the topics introduced to you in Modern Physics. However, in Modern Physics, you learned from the perspective of wave mechanics; here, you'll build up the physics from the principles of quantization and the spin-1/2 system. This course is broad, challenging, and extremely important for every physicist, so give it your fullest attention. Math will include lots of linear algebra and concepts from probability theory.
Recommendations: Around half of past physics majors have strongly disliked the textbook by Townsend used for this class, which often skips details of explanations and can be a difficult source to learn from. We recommend supplementing your readings with the corresponding chapters of Griffiths (for clarity) or Sakurai (for detail).

173.308 Advanced Physics Lab  
Tobias Marriage  
Junior or Senior Spring  
In this course, you'll recreate three real laboratory physics experiments. The work you do here is a lot closer to experimental research than that seen in the introductory lab sequence— you run experiments in your own time, analyze data, and prepare lengthy reports. You'll spend a significant amount of time programming in Python, and prior knowledge of the language will be helpful. Don't underestimate the workload just because this is a lab course – it actually tends to be heavier than most other physics classes.  
Note: You can take this junior or senior year. Some laboratory material appears on the Physics GRE (grad school entrance exam), though, so you may want to take it junior year if you can.  
Recommendations: Don't procrastinate. Lab reports take much longer than you'd expect, and you're graded heavily on content rigor and scientific writing. Go to the TA and Professor with any questions as early as possible. Photographs of whiteboard lectures or good notes will help.

**Other Courses:**  
You must take one of the following two courses to complete your physics major, but it is highly recommended (and expected by most graduate schools) that you take both:

171.312 Statistical Physics / Thermodynamics (Statmech)  
Peter Armitage  
Senior Fall  
Covers physics of many-particle systems. Important for research and recommended for everyone, especially those planning to go to grad school for physics. You'll learn important concepts in this course that you won't see anywhere else in the physics major, even though most engineers at Hopkins will learn about Thermodynamics early in their education. Math involves probability, statistics, and complicated calculus. This class is about estimation, not exact solutions, and will be different from all the physics courses in the major.  
Note: Thermodynamics is a topic on the Physics GRE (the graduate school entrance exam), which is usually taken in the Fall of senior year. It is debated whether it is
advantageous to complete Statmech before taking the exam, as that would require taking the class in the Fall of junior year- a semester in which you'll already be taking E&M II and Quantum Mechanics I.
Recommendations: Focus on the homework assignments. They can be quite long, but are very open, and don't hold your hand much. Get used to doing a wide variety of problems. The textbook readings are quite useful, but missing lectures will hurt you.

171.304 Quantum Mechanics II
Oleg Tchernyshyov
Junior Spring
A continuation of the material covered in 171.303. Highly recommended for everyone, especially if planning to go to grad school for physics. The course picks up right where the previous one left off. Mastery of the material from QM I will be assumed throughout, as more and more complicated cases and corrections are considered.
Recommendations: This course is extremely challenging, and it's very easy to get lost. There will likely be times when the best course of action will be to forget about physical intuition and allow the math to guide you. Seek help from the TA or Professor if you feel yourself starting to get behind, because the effect can quickly snowball.

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The rest of these courses are completely elective. Some are designed for non-STEM majors at Hopkins, but if they look interesting, you are welcome to sign up. This is not a comprehensive list; we've included most of the courses that SPS members have recently taken. Note: We are allowed to sign up for graduate level courses as electives if we obtain instructor permission.

171.101-2,103-4,107-8 General introductory physics courses
If for some reason you need to do so, you are permitted to take any of the general intro physics classes instead of the 105-6 sequence. We don’t recommend this; the classes for physics majors will benefit you more in a number of ways! However, you do have the choice of taking physics for engineering, physics for biological sciences, or active learning physics instead. The active learning physics course is probably the most engaging, since you'll solve problems in class with guidance from the professor and TAs.

173.111-2 General introductory physics lab
In the same way, you can substitute general lab for physics majors lab. Again, we don’t recommend this, as 115-6 are great ways to get to know your fellow majors. However, the scheduling is much more flexible this way, so this option may be useful.

171.118 Stars and the Universe
Adam Riess
This course is intended for non-majors, but can still be pretty fun if you have an interest in astrophysics. You’ll get to use multiple telescopes, and Professor Riess even passes his Nobel Prize around once per semester! Note: This course was not available last year, and we’re not sure whether it’s returning.

171.321 Intro to Space Science and Technology
Stephen McCandliss and Stephen Murray
Don’t be intimidated by the fact that this is a 300-level course- you can easily take it as a sophomore or even as a freshman if you’re able to register. You’ll be interacting with a lot of students from the engineering school. The crux of the class is a group project, in which you essentially design a space mission based on a topic selected by the class at the start of the semester. You have no control over which group you will be in. Groupwork includes presentations and a final report. The highlight of the class is a field trip to the JHU Applied Physics Laboratory- don’t miss that!
Recommendations: This course is important for anyone considering a career in the space industry and is required for those pursuing the Space Science & Engineering minor. It can also make for an interesting physics elective with light math requirements. The group project aspect can be very attractive to industry employers- just make sure you have a good spiel on your role in your group prepared. The textbook is your best resource, but the exams also cover additional material seen only in class. Be sure to stay on top of the deadlines.

171.310 Biological Physics
Mark Robbins
This course can be substituted for the second half of 171.201. It is recommended only if you plan to pursue a career in biology-related fields and is most often taken by Biophysics majors.

171.410 Physical Cosmology
Charles Bennett
This course serves as an introduction to the physics of the origins of the universe. While you should expect some math, the class is geared towards undergrads, so you won’t be
killed by the complications of inflation theory. Hopkins is world-renowned for its cos­mology research, and the professor for this course is a leader in the field!

171.411 Light and Optics
Brice Menard
This class teaches the basics of optical and propagation phenomena, such as refraction and lens physics. It is not mathematically challenging, and is designed to be accessible to non-majors. You should not expect the same level of organization and as you would from a major-track physics course. However, the subject matter is on the Physics GRE, and is not covered in any real depth by another physics class.

171.405-6 Condensed Matter Physics
Ari Turner / Peter Armitage
This course sequence covers the physics useful for condensed matter research and is accessible to students who have completed quantum mechanics.

171.610 Numerical Methods for Physicists (graduate level)
Colin Norman
While not all SPS members enjoyed this course, the content is extremely useful. If you’re not going to take it, at least consider picking up and reading Numerical Recipes by William Press. Its content is the standard for scientific computing used in research. All programming assignments can be done in any language, but one of the class’ choice (normally Python) is emphasized.

171.646 General Relativity (graduate level)
David Kaplan
Feeling brave? This course is among the most challenging available in our department. Math content, homework, and exams are all as tough as it gets. Topics covered are Einstein’s theory of gravity in curved spacetime. A rewarding subject, but not for the faint of heart. Offered every other year. 110.439 Differential Geometry is recommended as a prerequisite.

171.701-2 Quantum Field Theory (graduate level)
Jared Kaplan
This terrifying course sequence covers the most advanced theoretical physics known to man. That’s right, this is it. Basically, you’ll mathematically construct particle physics from the ground up. From what we understand, here you’ll die, and be reborn from the ashes as a theoretical physicist. Stated prerequisites include only undergrad Quantum I&II, a strong background, and either brilliance or cockiness.
Section 2: Courses Outside of Physics (and when to take them)

Math:
Your math courses will serve as the foundation for a lot of the physics you learn. It’s important to take them at the appropriate times, and to have a very strong grasp on what you learn. Important: We highly recommend that you take the most advanced math courses possible as soon as you can! Being ahead in math will make physics much easier.

Note: The JHU Math Department rotates which professor teaches every class each semester. It is therefore easy to avoid professors whose teaching styles don’t suit you, but you’re also frequently faced with professors who haven’t taught your course in many years (resulting in questionable pacing or content). As such, professors are not listed in this section.

110.106 Calculus I
Not recommended
We don’t recommend that any physics major take this course. If you have not previously taken Calc I or do not have credit for it, seriously consider instead taking 110.115. If you take this class your freshman fall semester alongside Classical Mechanics I, you will not learn the math necessary for the following physics courses in time. Academic advising may recommend that you retake Calculus I, even if you got credit for it in high school with an AP or IB exam. Do not listen! If you are feeling unsure of your grasp on Calc I, you may wish to take the course described next. Do not take Calc I – in the past, SPS members did not know this would be a problem and ended up behind and had no choice but to take summer courses to catch up. Calculus III is everywhere in E&M I, and both linear algebra and differential equations appear in Special Relativity & Waves. Those are already hard courses, and they don’t need to be made any harder!

110.115 Honors One Variable Calculus
Freshman Fall
If you would like some review of Calc I in college, or if you’d like to get a feel for what it’s like to study mathematics for theory, this is a good course for you to take during your Freshman Fall. It fulfills prerequisite requirements for both Calculus I and II. You’ll work in a ‘flipped classroom’ setting – no lectures, you learn all the concepts by working out proofs for yourself. Additionally, if you’ve never seen mathematical proofs before (not in the high school geometry sense), there’s probably no better way to learn good practices for rigor than this course.
110.109 Calculus II
Freshman Fall
Many physics majors take this course during their first semester at Hopkins. The main takeaway is probably Taylor approximations. The course is pretty standard, lecture style, weekly problem sets, etc. Don’t fret if your exam grades are lower than what you’d expect from high school – Hopkins math classes curve scores, with the average often sitting at around 65%.

110.202 Calculus III
Freshman Spring
This course covers multivariable calculus, a topic that will appear everywhere in Electricity & Magnetism I. You should take it during Freshman Spring at the latest, but take it during your first semester if you place in! It’s always to your benefit to be ahead in math. Pay special attention when learning about gradient, divergence, and curl, as those topics will appear again and again in physics.

110.201 Linear Algebra
Freshman Spring or Sophomore Fall
This course provides a deep understanding of vector mathematics. Every topic is extremely useful for physics. You will see a lot of this course material in Special Relativity & Waves, so we recommend you take it before starting your sophomore year if you can. Many majors choose to take it concurrently with E&M and Calculus III during their Freshman Spring semester, while others put it off until Sophomore Fall. Take it sooner if possible, but cramming it into Freshman year or the summer is not necessary.

110.212 Honors Linear Algebra
Freshman Spring or Sophomore Fall
A theoretical understanding of linear algebra can be extremely useful to a physicist, especially for Quantum Mechanics and advanced courses that follow it. However, a functioning practical knowledge is also critical for success as an undergraduate physics major, and SPS members have been dissatisfied with this course in the past. Be aware that, while taking this course can provide a deeper understanding of the mathematics underlying Quantum Mechanics, it also mandates a large amount of external practice in solving the linear algebra problems other students will get used to in the general course.

110.302 Differential Equations
Freshman Spring or Sophomore Fall
Study of equations involving functions and their derivatives. Critically useful for any scientist or engineer. We recommend taking it as soon as possible. Most physics majors take it sophomore fall, concurrently with Special Relativity & Waves – a class that contains a multitude of differential equations.

110.311 Complex Analysis
As desired after prerequisites
This course covers the use of complex variables, and some miscellaneous topics in analysis. A natural comfort with complex variables is critical to being an effective physicist, but most of the content here won’t show up in your undergraduate physics education. Contour integration is the most useful topic. Homework can be quite tedious. However, this course is always recommended for physics majors, so if the teaching is good, it’s worth a look. Not especially difficult, as math classes go.

110.401-2 Advanced Algebra
As desired after prerequisites
This sequence will give you a working knowledge of groups, rings, and algebras. The subject is the foundation of theoretical particle physics, so if that’s your interest, take these courses as soon as possible. They are far more proof-heavy than probably any other course at Hopkins, and are full of complicated concepts and difficult assignments. However, with a good professor, they can be extremely interesting and useful when related to Quantum Mechanics. Since they are difficult but important, physicists who will likely never use the content (such as a condensed matter experimentalist) can take the course as an S/U elective to familiarize themselves with the material conversationally.

110.405 Real Analysis
As desired after prerequisites
This course covers advanced mathematical techniques for solving complicated integrals and dealing with generally unpleasant functions. The subject is highly recommended to anyone who considers themselves a ‘mathematical physicist’.

110.415 Honors Analysis I & II
As desired after prerequisites
This two semester in-depth course normally takes the place of 110.405 in the education of an ambitious pure-math major. Highly unusual functions will appear throughout, with more of a focus on theory and proof than the alternative course offers.

110.417 Partial Differential Equations
As desired after prerequisites
This course is often recommended by professors and seldom by undergraduates. While the subject matter is potentially interesting and useful to a physicist, this course’s content has little discernable use. The main topic covered is separation of variables, which will also be taught in more than one physics major course. Only a few PDEs are actually considered, and the work quickly grows repetitive, in our experience. A different professor may teach the course differently, though, so keep an open mind.

110.439 Differential Geometry
As desired after prerequisites (before General Relativity)
This course teaches you how to perform differential calculus on 1-D curves and 2-D surfaces in a 3-D space. You will learn ways to describe these objects mathematically. Reminding yourself of vector spaces from Linear Algebra and the first half of Calculus III is useful. Overall, this is not a hard course if you put in some effort. The class size is usually quite small. Beyond being generally interesting, this course is potentially useful for introducing some of the mathematical concepts that will be encountered in a General Relativity course, and it’s often recommended that you complete this course before attempting that one.

Applied Math:
Courses in the Applied Math department can be useful for many applications of physics, as well as research. They’re often very well taught and can be extremely useful to a physics major. Some important courses offered are:

550.171 Discrete Mathematics
Beryl Castello
This course is designed to be an introduction to proof-based mathematics, through the lens of combinatorics and integer mathematics. If you’ve never seen a proper mathematical proof before, you should be aware that academic mathematicians work on them exclusively, and you should probability seek some familiarity with them before attempting something like, say, Algebra. However, this course is usually seen as quite low-level and simplistic by physics majors, and since the content is mostly identities you can look up, it might be worth skipping. Applied math majors must take a discrete math course, but not necessarily this course, and courses like 550.371 Cryptology or 550.471 Graph Theory may be more interesting. For an introduction to proofs, consider any of the lower-level pure math department classes with ‘Honors’ in their title.

Probability and Statistics
Various
You have a few options here. Many physics majors take 550.310, which is a one-semester course on probability and statistics for application in the physical sciences. It’s relatively simple, but teaches a lot of useful material. Physicists interested in a more rigorous view of the subjects can instead take 550.420-430, a two semester course that dives into more theoretical aspects of the subjects. The teaching for those two courses is really fantastic! (Note- the excellent professor for 550.420, John Wierman, will be on sabbatical in 2015-16.) Physics majors found 550.420 incredibly useful (especially in Quantum Mechanics and Statmech), but noticed that much of the material covered in 550.430 is also covered briefly in Advanced Physics Lab.

550.361-2 Intro to Optimization
Donniell Fishkind
This two semester course sequence covers optimization methods. Computation techniques are emphasized. You’ll learn MATLAB, as well as many useful techniques for research. The first course in the sequence is probably sufficient for undergrad physics purposes.

Programming & Computer Science:
We recommend that every physics major learn how to program as soon as possible! It’s the easiest way to quickly open doors into research for yourself. For simple utility in research, you can probably teach yourself a language like Python on your own time using a website like www.codecademy.com. However, if you want a more formalized education in programming and/or computer science, think about taking these courses:

580.200 Intro to Scientific Computing in Python, Matlab, and R
Michael Beer
Although this class is designed for BMEs, the programming experience can be good for everyone. Python, Matlab, and R are three languages physicists use frequently, for general programming, matrix manipulation, and statistics respectively. Just be aware that many of the example problems will be BME-related.

250.205 Introduction to Computing
Carolyn Fitch
This class can be tedious in the moment, but it teaches several useful skills that will apply far into a physics career (or any career that involves programming, really). It’s offered by the Biophysics department and the grading scale is usually much more lenient than the BME course. The class covers working in the UNIX environment, elementary Python and MATLAB. The exams are not too difficult, and have been take-home in the past. If you haven’t programmed before, this course is good for easing
your way into it. Otherwise, it may seem very light when compared to courses from the Computer Science department or 580.200.

Recommendations: Google is your friend when it comes to homework. There are some progress deadlines for the final project (which you can choose to tackle in a group), so try and stay on top of those.

[*More courses to come!]

**Writing Courses:**
With physics as your primary major, Hopkins requires you to complete 12 credits (usually four courses) of writing classes. Our Advanced Lab course is writing intensive, so that will fulfill 3 credits. If you choose to write a senior thesis, that will fulfill 3 more. To complete the remaining requirements, you have many options in departments like Writing Seminars or History. However, if you’re looking for something less traditional / essay focused, SPS members have finished their writing requirements using courses such as:

661.150 Oral Presentations
A weekly course on public speaking. Practicing this skill is important for nearly every profession, and the course is lighthearted and is often tailored to your interests. Not difficult, extremely useful, and highly recommended for content and fun.

661.105 Intro to Business
General practices for working in the corporate world. Useful to any physicist considering a career in industry, and relatively easy writing assignments.

220.206 Writing About Science I
David Grimm
Science communication is a growing field, and discoveries must be reported to have impact. This course will teach you the basics of science journalism. Scientists will visit class, talk about their (always extremely interesting) work, and you will go home and do the assignment based off of their talk. You will become a better writer, and be exposed to lots of interesting research outside of physics! Note that you may have to submit a short writing assignment to get permission to enroll.

**Other Courses:**
To round out our course listing, here are a few courses SPS members took as electives that they found particularly interesting as supplemental material to their physics major:
180.101-2 Intro to Economics
Learning about economics can be rather informative for a physicist, since it’s a completely different way of thinking from what we’re used to. The intro level courses should be a breeze if you’re mathematically inclined, and who knows, you might learn something to help supplement your salary someday.

376.242 Intro to Popular Music
David Smooke
Looking for an elective credit? This course is plain fun. You’ll learn about the progression of American culture through the twentieth century by way of classic rock-filled Spotify playlists. Laid back, interesting, and listening to music for homework can be a nice break from physics problem sets.

200.208 Animal Behavior
Farrah Madison
This course is fairly easy, and has interesting content. The focus is largely on avian behavior and mating habits. Recommended only if you are really interested in animals and have a particular affinity for memorization.
Recommendations: In the past, there were three midterms, a final, and a paper, but no other assignments in between. That being said, you should stay on top of the reading and make flashcards, because the exams come up fast, there’s a lot of material, and exam questions can get pretty specific. Additionally, don’t wait until the last minute to write your paper!

030.101-2 Introductory Chemistry I/II
Various
The material in these courses is not difficult, but is also introductory and not particularly exciting. However, chemistry (both introductory and organic) is quite important if you want to focus on condensed matter physics. Additionally, every physicist should have at least a working knowledge of basic chemistry, so if you don’t have a good background in it from high school, taking these courses is probably a good idea.

[More courses to come!]

Section 3: Degree Options and Double Majoring
Currently, Physics undergrads at Hopkins have five degree options: a BS, a BA, a four-year combined BA/MA for the truly ambitious, and two minors, one in physics and one in space science. The requirements are as follows:
The BA degree is designed to be flexible, and is usually pursued by students who do not plan to have a physics-intensive career. It requires the physics classes listed above under “Required for the Major”, the five required math courses also listed above, and two 300+ level approved electives.

The BS degree option offers a chance to become more specialized. It is meant for students who are planning to spend their careers in a very physics-related field, and is usually selected by students planning to pursue a PhD in physics. It requires the same “Required for the Major” physics classes and five math classes as the BA, but then also demands six upper-level elective courses, at least four of which must come from an approved sciencey department on campus. See the department website for details.

The BA/MA program was just recently created by the department at the request of SPS members. To complete this rigorous program and begin your graduate studies early, you'll need to pass six approved graduate-level physics courses with a B- or better, and write a research report. Up to two semesters of supervised research can be substituted to fulfill the course requirements. If you are considering this program, you need to sit down with Collin Broholm, our Director of Graduate Studies, and chat about what it would entail for you.

The physics minor is often pursued by students who take the introductory physics sequence and discover that the world of modern physics doesn’t interest them as much as they expected. Students in engineering or other related majors also complete it if they want a more fundamental understanding of their area of specialization. The requirements are simple: any version of classical mechanics and E&M, Contemporary Physics Seminar, and four physics department 200+ level courses.

The space science minor is usually pursued by physics majors interested in astronomical instrumentation, or engineers who want to specialize in space technology. 171.321 Space Science and Technology is a required course, and the minor also requires four additional courses which must be discussed with an advisor who will be assigned to you when you declare your intent to complete the minor to the Academic Advising office and the Registrar. Professor Charles Bennett is in charge of this degree program. He is a good resource for more information, as is the department website.

The department does not offer ‘area of focus’ tracks for astrophysics or particle physics or any other specialization. Many other departments at Hopkins do this, especially in the School of Engineering, but our philosophy is that an undergraduate program in physics should cover all of physics. Your research and your elective courses should be used to crack into your chosen field when you choose one, and grad school is where you’ll really specialize if you choose to go.
Many Hopkins physics students choose to double major. Since Hopkins lets you double count classes, it’s not very difficult in most cases. The most common choice is Mathematics, since doing a physics major completes half of the math major automatically. Other common choices include Applied Math and Computer Science. Psychology seems to be done fairly often, and we’ve recently even seen things like Writing Seminars, Economics, or History. If you do choose to double major, do it in a field that supports what you’d like to do with your physics degree. If you want to be a high energy theorist, for example, doing a math degree will probably help you.

Note that physics majors are required to take at least 18 credits of Humanities or Social Science courses, which usually translates to 6 classes. Many SPS members chose to take all of those classes in the same department, and finished a minor such as Classics or Music.

If you end up doing exceptionally well in physics, there are a few ways that the department will acknowledge that. If you graduate with a GPA of 3.5 or better in the courses required for your physics major, you’ll be rewarded with Departmental Honors. If you are among the top third of your physics graduating class, you’ll be inducted by SPS into ΣΠΣ, the national physics honors society, after completing E&M II and QM I.

Section 4: Thinking of Being a Physics Major?
Many students arrive at Hopkins torn between physics and engineering or some other discipline. Some others feel quite certain that physics will be their major but later discover they’d rather do something else. As such, we’ve compiled some advice on how to tell if a physics major is right for you, and what to do if you’re considering starting the degree program.

Let’s say you’ve arrived at Hopkins and you’re trying to decide whether you want to study physics or some type of engineering (or maybe you’re considering a double major). The best way to go about deciding how far you want to pursue physics is to begin following the physics major path as intended, but stick to the courses that will also count for the other major you’re considering. Almost every engineering needs to take some form of Physics I&II (Hopkins offers four flavors of each), so taking the physics major-intended 171.105 Classical Mechanics I and 171.106 E&M I is the best thing you can do. These classes will show you what it’s like to major in physics at Hopkins - they’re taught in the same style as all the rest of the classes in the major (on the order of 25 students, collaborative spirit, nontrivial weekly homework, math emphasis), and will also give you a chance to meet all the rest of the students with whom you’d be moving through the physics track.

You could also consider taking 171.202 Modern Physics during your freshman spring semester. While that course is usually taken by sophomores, it’s not very difficult, and is designed to be accessible to both majors and non-majors as an introduction to all
higher-level physics subjects. The content you see in that course is a good indicator of what you’d see throughout the rest of your physics education; majoring in physics and being a physicist nowadays has almost nothing to do with the classical mechanics you saw in high school! If solving projectile motion problems was your favorite thing about physics, take a look at this stuff before committing to a major - the main location you’ll find classical stuff is in engineering.

While you do all of this, it would be wise to get as many of the courses you know you’ll have to take eventually out of the way as fast as possible. If you’re choosing between physics and engineering, take all of your math courses immediately, for example. This way, if you decide to change your mind, you won’t have wasted any time.

Section 5: Flexibility in the Major
Our department has spent years designing and redesigning the path it intends its undergraduate majors to follow through their coursework, and it’s recommended that you do so. However, many situations can arise that might lead you to break out of the track.

Students with exceptional high school backgrounds often skip the freshman year courses and begin their majors with 171.201 Special Relativity & Waves. This is difficult, because even strong AP Physics C programs usually do not cover the introductory physics material in as much depth as we do (this is especially true for 171.106 E&M I), and furthermore few students arrive at Hopkins with a sufficient math background for the waves course. Students who do skip the first year courses also miss out on traveling through the major with all the other physics students in their class. However, the advantage to doing this is that it opens up additional time for advanced courses and can allow a student to become a very strong candidate for graduate school. It’s often recommended for skilled mathematicians serious about a career in high energy theory.

Several students have delayed either 171.204 Classical Mechanics II and/or 171.301 E&M II until junior spring or senior fall, respectively. While this does technically put you behind, the content in those courses does not appear again in the remaining courses in our undergraduate curriculum, so doing so doesn’t present any immediate problems and can often resolve schedule conflicts or reduce a heavy semester’s workload.

Both 171.312 Statmech and 173.308 Advanced Lab can be taken during either junior or senior year. This is a matter of preference, but completing them sooner will help you prepare for the related content that shows up on the Physics GRE.

It is possible, but dangerous, to skip the undergraduate sequence on quantum mechanics entirely and move directly to the graduate courses on the subject during junior year. This would free additional time for graduate courses in an accelerated curriculum.
Essentially, with the approval of your departmental advisor, you can follow any reasonable path through our physics courses that you wish. Discuss your motivation and what you’re capable of with them extensively before making any grand decisions.

Chapter 2: Research

Section 1: Doing Undergrad Research
Chances are, if you’re a student at Johns Hopkins, you’ll be doing some kind of research before you graduate. Usually, for physics students anyway, this means getting involved with a professor on an existing project. Research usually functions similarly to an on-campus job, and you may end up doing it for credit, cash, or nothing at all. Since you’re still learning, a lot of what you work on at the beginning will be learning specifics about your group’s project, but later on you can make serious contributions and maybe even get your name on a paper or two. Research is a great asset to have on your resume, for grad school or otherwise. SPS encourages you to start getting involved as soon as you want to!

Section 2: How to Get Started
So, how do you find a research project that you can join? The most general answer is to talk to people around the department. Getting started on a project is usually as simple as letting the right person know that you’d be interested and motivated to work with them. To do that, though, you need to figure out who you’d like to work with! Spend some time exploring the “People” page on the department website – you’ll find a description of each professor’s research there. The department also hosts open houses and research fairs (often aimed at grad students but open to everyone), which can be a great way to see who’s doing what. You’ll also hear about a lot of professors’ research projects at SPS talks, so definitely attend all of those!

Once you’ve narrowed it down to a few choice projects, start contacting professors. Sending emails can work, but many of us have found that simply walking down the hall and knocking on someone’s door can be more effective. SPS events, department talks, and even after classes are also great places to start a conversation with a someone. Let the professor know that you’re interested, and why. Most of them have worked with tons of undergrads before, so just be yourself. They’re looking for genuine interest in a project – don’t try to work with someone just because they’re a big deal. One of the greatest things about our department is that the faculty treats undergrads like colleagues, and will respect you. No need to be over-excited; you’re a Hopkins physicist, and that makes you a pretty big deal, too. Not all professors in the department are looking for undergrad help at any given time, but often they’re willing to
work something out with you. You might not get paid, but you can always get credit for research.

That said, it’s really helpful if you have something to contribute to a research project. If you want to start working in your first year or two, programming skills are usually a must. We recommend you sharpen your skills as soon as you can, through a class or simply teaching yourself with the assistance of online resources (ask us for website recommendations!). Python is usually the language of choice for physicists, with C++ a close second. It’s just often hard to understand everything involved with a project before taking quantum mechanics, but there’s almost always programming work you’ll be able to do. It’s all very project-dependent.

Section 3: Types of Physics at Hopkins
There are many large fields of study contained under the umbrella of ‘physics’. At Hopkins, we focus mainly on three. Below, we’ve described what kinds of work our department is known for, and listed a few friendly faculty members you can try talking to if you’re interested in learning more or getting involved early on. If you’re looking for a particular person’s office, check out the department directory, on the wall near the large ascending concrete staircase in the rotunda.

Subsection A: Astrophysics
This is the stuff that our department is most known for. The Space Telescope Science Institute (HUBBLE) located across the street, and many members of our faculty are true leaders in the field right now. There are many listable names here, but we’ll name a few who often interact with SPS or take on undergrads:
- **Charles Bennett** led the WMAP experiment and is now working on constructing the CLASS telescope array.
- **Tobias Marriage** is also working on CLASS, and employs many undergrads to help build his telescope experiments.
- **Julian Krolik** studies astrophysical black holes and is also always happy to offer advice to undergraduates.
- **Adam Riess**, 2011 Nobel Prize winner, is famous for his studies of Dark Energy and calculation of the Cosmological Constant.
- **Nadia Zakamska** studies active galactic nuclei and supermassive black holes physics.

Subsection B: Particle Physics
Many members of our faculty are involved in the CMS collaboration and work with scientists at CERN. If you’re interested, a few faculty members to talk to are:
- **Petar Maksimovic**, our SPS advisor, works on Z- and W-Boson tagging.
Morris Swartz is the department point-person for collaborations with CMS. Andrei Gritsan has undergraduates help him analyze LHC data from CMS. David Kaplan recently made waves in the world of physics with his movie, Particle Fever!

Subsection C: Condensed Matter Physics
Condensed Matter Physics is the study of materials in interesting new states of matter. This includes semiconductor physics, friction, low-temperature physics, superconductors, device physics, and lots more. Some people to talk to in our department:
Peter Armitage recently worked on topological insulators and also does low-temperature work.
Daniel Reich works on soft (biological) condensed matter physics, and collaborates with Howard Katz in the Materials Science department.
Robert Leheny works on liquid crystals and soft condensed matter physics.
Collin Broholm is an expert in neutron scattering experiments and is also our Director of Graduate Studies.

Subsection D: Other Work
While most of our department’s work falls into the above three categories, you can find some faculty doing other types of physics if you look hard enough:
Michael Finkenthal researches plasma physics and teaches a class on it every year.
Alex Szalay studies astrophysics, but from a very computer-sciency standpoint. He is the director of IDIES, Hopkins’ big-data project.
Gregory Eyink has a joint appointment with the Applied Math department. He works in statistical physics, studying turbulence. His office is in Whitehead Hall.
Jack Morava is a joint professor in the Mathematics department and is probably the only string theorist you will find at Hopkins. His office is in Krieger Hall.

Section 4: Internships & Summer Work
Many freshmen don’t realize that the way you spend your summers can be as important to a successful college career as what you do during the semester. Summers are your time to begin getting experience in the field you’ve chosen.

Physics majors often accomplish this with research jobs or internships. These (sometimes very competitive) positions can be difficult to come by, but early planning combined with a good track record at Hopkins has proven to be successful in landing positions. You can find internships called Research Experiences for Undergraduates (REUs) at many major universities. REUs usually pair you with a faculty member for
work on a new or, more often, existing research project. REUs are paid, and usually include housing at the host university. You'll also find very similar programs, called Science Undergraduate Lab Internships (SULI), at the country’s national labs, such as Brookhaven and Lawrence Berkeley. SULI programs tend to be much larger than REUs. Many of these summer positions will involve programming, chemistry, or both, since young physicists must often use those skills. You can find other internship listings on the National Science Foundation website, the National SPS website (SPS usually offers some unique science policy internships, too), and other places online. Don’t be afraid to look outside of your comfort zone, either – internships overseas (like the INFN exchange in Italy) or in areas other than physics research can be extremely rewarding. If you have no idea where to start, check out the internship listings hosted on the JHU Career Center website, or go chat with those advisors in person in Garland Hall. You can also take a look at the SPS website, where a listing is sometimes maintained, or talk to older SPS members to find out how they spent their summers.

If you want a summer internship, start looking in the fall. Many application deadlines are January 1st, and some are as early as November. If you want until the Spring, you’ll be scrambling and probably won’t find what you want. Get it out of the way really early so you don’t have to worry! For a listing of internships recently held by SPS members, see Appendix C.

Doing research with a professor at Hopkins can be very helpful to your application for internships. You’ll be able to show that you have lab experience, you’ll have some applicable skills, and you’ll be able to ask that professor for a much more in-depth letter of recommendation.

Another summer option is sticking around Hopkins to do research. If the kind of work you want to do is available at Hopkins, see if you can find a professor who would be willing to take you on for summer work. You won’t make as much money this way, and it can be great to make connections outside of Hopkins, but this kind of summer will allow you to get really deeply involved in a research project that can continue throughout your undergraduate career that can lead to a senior thesis or other desirable results. Plus, our professors usually love the help, since summer is when they really get to focus on their research.

Physics majors can often get funding for a project at Hopkins through the Dean's or Provost's Undergraduate Research Awards. If you're interested in working with a professor but their lab would have trouble taking you on, these awards can provide funding in exchange for some publicity for Hopkins. Information can be easily found on the University website - note the application cycle is early every semester!

If you do something exciting with a summer, let SPS know right away – we usually hold an event every fall where returning members can tell the new ones about their research or other work.
Chapter 3: SPS & Other Resources

Section 1: SPS

Alright, this is our big chance to advertise. Listen up!

The Society of Physics Students is a national organization for undergrads studying physics. Its national goals are to connect physics students everywhere and give them opportunities to take their educations to a higher level.

Our chapter at Hopkins is a student club meant for every physics major (and others with interest) to join. We hold meetings, events, talks, and more so that our physics majors can be a part of a community beyond simply seeing each other in classes. Our department is a lot more close-knit than many others at Hopkins, and SPS is a big reason why!

SPS holds weekly meetings, plus some extra events. Our meetings usually alternate between a talk geared towards undergrads and a social event. We've had talks on subjects from cosmology to differential equations, and events including laser tag, barbecues, physics jeopardy, murder mysteries, and more. We always serve pizza at our meetings, too.

A few of our events deserve some extra attention. Our most significant event each year is probably the annual Feedback Session, held at the very end of each Spring semester. There, members of the department join us for refreshments and listen to our suggestions for changes around the department. They always deeply consider everything we have to say, and some really important changes have taken place as a result of these events, from simple textbook changes to the allowance of double-counting classes for two majors all around Hopkins.

SPS is also generously given the opportunity to tour national lab or other physics-related location each Spring break. We’ve traveled to Brookhaven, SLAC, Kennedy Space Center, and even CERN, all on the budget of our department. This opportunity is always offered to the most active SPS members first (the secretary is keeping track)!

We also recently began a tradition of concluding each semester with a LAN Party, hosted in the PUC Lab (explained below). Our tech officer sets up servers, we bring laptops and Steam accounts, food is delivered, and everyone has a good time.

SPS also offers its members many resources. In addition to providing you with connections to knowledgeable upperclassmen, the club coordinates tutoring efforts and also maintains an SPS-website-hosted chatroom intended for homework discussion. Additionally, active SPS members are allowed access to the SPS office, located adjacent to PUC Lab. It contains a small science library, a computer, and a coffee machine, and fridge. It's useful for quiet study, storage, or even a nap during a long day.
In addition to our own chapter’s services, many benefits are available to members from the National SPS organization. Becoming a member costs around $30, but includes membership in the American Physical Society and subscriptions to two journals of choice. Being a member allows you to apply for SPS scholarships and internships, and can connect you to other schools around the country.

We’d love it if, even if you don’t become a member of our chapter, you came to at least one SPS meeting. Join our mailing list so you can get updates about what’s going on, too. We hope we’ll be seeing a lot of you!

Section 2: PUC Lab
Our department is very kind to us. Room 478, called the Physics Undergraduate Computing Lab, is a lounge area on the fourth floor of Bloomberg set aside for undergrads to use. It houses nearly endless whiteboard space, couches and armchairs, and about a dozen computers equipped with useful software for physics work. More importantly, though, the PUC Lab is where you’ll find most physics majors doing all of their studying. Older students, especially those you’ve met in SPS, can be a great resource for homework help, as they’ve already made it through whatever class you’re taking. Everyone is friendly, so just ask!

Physics majors can access the PUC Lab 24/7, any day of the year. A quick Google search for “JHU PUC Lab” should bring you to a webpage (also linked on our SPS website) where you can request JCard encoding for access. So they can enter the building at night, physics majors can also obtain a key to the Bloomberg building for a deposit of $5 by talking to Brian Schriver in the office suite on the 3rd floor.

Section 3: Physics Resources
If your physics classes aren’t far more challenging than what you experienced in high school, something’s not right. Everyone in our department is brilliant, and the course difficulty is adjusted as such. With that in mind, don’t be surprised if you need some help on the side from time to time! The physics department has put a ton of educational resources at your disposal:

Your first line of defense should always be your classmates! Physics is a collaborative field, and working together with someone will probably boost your problem solving abilities more than you’d expect. Just make sure you’re not letting them solve all the problems for you!

Next up, try the TA for the class in question. They’re almost always graduate students, and are literally hired to help you. Send them emails, go to their office hours, ask lots of questions in section meetings. It can be especially useful to go over homework problems you solved incorrectly with them.
You can also stop by the Physics Help Room, located on the ground floor of Bloomberg across from the elevator. There you'll find TAs who should be able to help you with questions from any part of physics, although they most commonly deal with students taking the non-major introductory courses.

If you've got a particularly strange question or are confused about a lecture, try stopping in to see the course’s professor. They’re often pretty busy and can be hard to pin down sometimes, but no one can answer your questions better than they! The office hours they have scheduled are for your benefit, and some will even be pretty sad if nobody comes to visit.

If all else fails, we've often learned things by leaving problems on the whiteboards in PUC Lab with a note asking for help. You may come back a day or two later and find a response from another student whose thoughts can push you in the right direction.

Most useful of all, though, are the resources SPS can offer you. Wink wink. First, being a member will introduce you to a lot of upperclassmen who have probably already completed whatever course you’re in the midst of. They’re usually very willing to work on a problem since it’ll serve as a refresher for them. SPS members also have access to a large library of physics textbooks not used in class, and you may be able to find a good answer to a question if you flip through a volume or two. Additionally, SPS maintains an IRC chatroom, linked from our website, in which (albeit usually scarce) members are asked to help anyone who stops by with a question. Finally, SPS coordinates tutoring services in physics for students throughout Hopkins. Contact the SPS President if you’d like to hire a tutor, but note that if you require more than a small amount of face time, this may not always work out to be free.

Section 4: Other On-Campus Resources
In addition to those around our department, there are many resources available around Hopkins that may prove useful to physics students. If you’re looking for some additional academic help, there are a few places you can try. If the mathematical side of physics is giving you trouble, try stopping by the Math Help Room on the second floor of Krieger Hall, where math department grad students will help you work through any problem. If a specific class is giving you trouble, you have a few options. First, if that class is one of the big courses required by a lot of majors (lower level science and math courses), you can sign up at the beginning of each semester for PILOT, a program in which you’ll meet weekly with other students in your class for undergrad-guided problem practice. Many SPS members have found PILOT extremely helpful. You can also stop by the Learning Den, a peer tutoring area located in the Hut reading room across the café in Gilman Hall, for some quick help in a wide variety of subjects. Also located inside the
Hut is the Writing Center, a great resource for any student who’d like some feedback on any kind of writing.

Accomplishing anything at Hopkins can take a lot of planning, which is why the school assigns us so many advisors. All freshmen in Krieger School are assigned a general academic advisor prior to arriving at Hopkins, who will sign off on your first schedules, and explain general school degree requirements. After you declare your majors and minors, you’ll be assigned one advisor per degree program you enroll in, all of whom will have to speak with you at least once per semester. They are a great resource for advice about which classes to take and how to proceed academically. You’ll also receive an advisor for pre-professional programs and for study-abroad endeavors. Make use of their experience as often as you feel necessary. If you declare your physics major at the end of your freshman year, you’ll be assigned a departmental advisor over the following summer. Our department usually does an excellent job of matching our advisors to our interests. This person is a great resource for course advice, but becomes more and more important as graduation approaches, so form a good relationship with them early on!

If you need to do some background reading for a research project, you can ask for a librarian knowledgeable in physics at the circulation desk in MSE Library. They’ll be very happy to help you navigate the extensive science collections located on C Level of the library, and can also show you how to access online journal databases using Hopkins access codes.

While you’re at Hopkins, you’re not just a physicist; you’re a college student, and that often comes with a lot of stress stemming from both academic and social sources. It’s so hard to study a complicated subject like physics when you’re not feeling your best, so we encourage you to keep yourself relaxed. Hopkins knows how stressful our work can be, so it offers undergrads a ton of resources to reduce stress levels. On Mondays, for instance, you can head to Brody Learning Commons for a free backrub from the JHU Stressbusters. If you’d like to chat about your troubles, A Place To Talk is a student organization that trains peer counselors, who will listen to anything you have to say every weekday evening in AMRII or Wolman. You can also chat with your Resident Advisor anytime you need to – that’s why they’re there! Additionally, SPS is always ready to help its members, and you can always send an email to anyone on the board if you’d like to chat with us – we stood where you did once, and we might have shared your experiences.

One of the best ways to keep stress down at Hopkins is to take your mind off your work with some fun club activities or events. Many SPS members are also a part of other interesting clubs, such as improv comedy, quidditch, pen and paper gaming, dance, fraternities and sororities, a capella, quizbowl, tour guiding, equestrian, rifling, theater, and more. Chat with some members if you’re looking for something fun to take
your mind off your homework! SPS also maintains a chalkboard for external event announcements outside of PUC Lab and the SPS Office - members will write advertisements for upcoming events they're a part of, and you should add your own!

**Chapter 4: Getting Involved**

**Section 1: In the Department**

Our department is a bustling hub of activity in the world of physics. Events happen frequently, from talks by Nobel laureates to our annual holiday party. Get involved and don’t miss out!

Note: Many department activities are operated out of the main office suite Bloomberg 366, located on the third floor in the telescope atrium. You'll probably have to visit many times if you become involved!

**Subsection A: The Physics Fair & Other Outreach Events**

By far the most important department event each year is the annual Physics Fair. Every year, during the same weekend as Hopkins holds Spring Fair, our department pulls together to host a large-scale outreach event for children in the Baltimore community. Hundreds of live demos, shows, and activities are run at once by professors, grad students, and undergrads working together. Everybody volunteers for whatever they think is fun, we all get t-shirts, and show how fun physics can be to the public.

Throughout the year, SPS and the physics department hold other outreach events for the community for which your help would be much appreciated. Look out for event opportunities posted to the SPS mailing list, and contact the SPS outreach officer if you have any ideas to share.

**Subsection B: Open Houses & Prospective Students**

Starting to think our department is pretty great? We agree, and it’s to everyone’s benefit if you help demonstrate the department’s good qualities to our visitors. Throughout the year, Hopkins holds open house events (you may have attended some as a prospective student), and you’ll often see emails to the SPS mailing list sent by our administration asking for student help with those events.

Professors attend every open house event, but undergrads tend to have an easier time communicating with prospective students, so if you can help out, you should! These events are great opportunities to toot your own horn and explain why physics at Hopkins is among the best programs you’ll find anywhere. SOHOP and Orientation are especially important! Follow the lead of the professors running the session, and be honest but try not to scare anyone off!
Fairly frequently, prospective students will contact the department to request a more physics-focused tour than those provided on campus by Blue Key Society. When this happens, the department administration will usually again email the SPS list for help. It can be really fun to chat directly with high school students and their families, and they always really appreciate it, so please volunteer for this if you can! No training necessary - just talk about your experiences.

Subsection C: Other activities
You can also make a splash in the department in other ways. For starters, definitely show your face at our frequent barbecues, holiday events, and picnics – it’s a great way to meet faculty and other students and to make a good impression. If you’d like to be involved in actually planning such events, the easiest way to accomplish that is to join SPS, as we (especially board members) are often heavily involved in planning activities that occur around the department. We can definitely use your help!

You can also help out the department more directly by applying to be a TA for the general physics courses. If you’re selected, you’ll be helping non-majors learn, grading their homeworks, and meeting with professors to discuss lesson plans. These positions are paid by Hopkins, and can be very rewarding. SPS members have become TAs as early as sophomore year in the past! Speak to the professors teaching general physics (171.101-2, 103-4, 107-8) to apply.

Section 2: Furthering Your Physics Education
Only a fraction of the world of physics is shown to you in the classroom. Your professors will teach you all the important laws and equations, but the stuff on the cutting-edge won’t show up very often on the blackboard. SPS encourages you to expand your view of the world of physics by going to talks, reading the literature, travelling to meetings, and taking any opportunity that presents itself.

Subsection A: Going to Talks
Attending extra lectures is a physicist’s favorite way to keep current with their field. Our department (and the rest of Hopkins) hosts such talks on a daily basis. The subjects, speakers, and settings can range from broad overviews of new science from Nobel Prize-winning guests of the university given in our large auditorium to detailed looks at currently active experiments given by graduate students over coffee or wine and cheese. Undergraduates are almost always welcome to sit in for any talk. Full listings can be found on the SPS website, the
department website, and posted on bulletin boards around Bloomberg. Enjoy the customary wine (if you’re 21) and cheese!

Many of the department’s talks are targeted at an audience with high-level knowledge of physics, though, and freshman especially will likely find themselves getting lost. That’s okay, it gets better, we promise! However, SPS also seeks to solve this problem by organizing a series of talks each semester during some of our weekly meetings. Our talks are aimed at undergraduates, and usually come from professors around Hopkins doing research that could be interesting for an undergrad to become involved with. We also serve free pizza at all our talks!

Subsection B: The Literature

Physics, like so many scientific fields today, is a journal-based research discipline. When researchers today complete research projects, they seek to have their results published in one of many physics-dedicated magazines or newsletters. Once you’ve gained a cursory understanding of modern physics, SPS encourages you to purchase a subscription to *Physics Today* and/or other similar journals. Even if you don’t understand everything written, it’s great to keep up with the field you’re entering, and interesting articles can also serve as great topics of conversation with members of the department.

You can get your hands on these materials in a number of ways. The most sensible way is to become a member of the National SPS. This is something you should do anyway, as membership offers many scholarship and internship opportunities, as well as other benefits. But your membership fee will also cover a subscription to *Physics Today* and another journal of your choice, so it’s a great deal. You can also look for copies of magazines on coffee tables around the department, and read materials in the SPS office, MSE, or online through the Johns Hopkins Sheridan Libraries system.

Subsection C: Travelling to Physics Meetings

If you happen to come up with some particularly cohesive results while doing physics research as an undergrad, you’ll probably be interested in presenting those results! You’ll have ample opportunity to do that at Hopkins, but if you’ve got something really interesting, you may be able to attend one of the many annual physics conferences that happen around the country. You’ll really need to chat with your research advisors before doing this, but we’d like to let you know that the National SPS has a lot of travel funding available to fund members to attend such conferences. The Women in Physics conference has also been a popular destination for our majors recently (regardless of their research
experience). It usually takes place around the beginning of the calendar year, and the department will pay your expenses.

You’ve reached the end of our handbook (we hope it helped!); here’s one last reminder of all the opportunities that will be afforded to you if you join SPS! Come to any of our meetings or events to join!

Appendix A: Advice
Below, you’ll find general tidbits of advice collected from SPS members in no particular order.

Don’t be afraid to leave your research group. The project you joined up with after freshman year might not match your interests anymore! It’s better to change research and do something productive with senior year. Professors will absolutely understand this - they don’t expect undergrads to know their interests exactly.

Take the required classes first and leave electives until later. Get things out of the way as soon as possible, because Hopkins scheduling will often bar you from things you want to take during a particular semester. Having an 8-semester plan never works out the way you want it to. Taking the required courses first also makes it less likely that you’ll regret wasting time on something at the beginning of college. Plus, junior and senior years are super busy, so the lighter your course load, the better. Plus, you’ll look better on paper for grad school with advanced courses done early!

Don’t go to graduate school for the sake of going. You will probably feel some pressure to go from those around you, but that’s because you’re at a university and everyone here decided to go to grad school. You might find industry work more enjoyable, and despite what The Big Bang Theory might tell you, you’re not “selling out!” Grad school in physics should be reserved only for those who are positive that that’s what they want.

[*More to come!]

Appendix B: Internship Testimonials
In this section, you’ll find reviews of the experiences past SPS members have had at the various REUs and other internships they’ve held during their summers. Read through if you’re looking for one yourself!

Format:
Internship location and type
Note: REUs, or Research Experiences for Undergraduates, are the most common type of internship available to physics majors. For typically 10 weeks, you live in guest housing at a host university (Yale, Texas A&M, Chicago, etc.) and are paired with a mentor from among the physics faculty there. In a good REU program, your mentor will have a project prepared for you to tackle within the duration of your stay. These programs usually conclude with short formal report, but in exceptional circumstances can yield a publishable paper. You’ll be paid a stipend of around $300-500 per week, and there are often a dozen or so students at each university at a time.

Brookhaven National Labs SULI / SURP - Upton, NY
Vittorio Loprinzo
Sophomore
The US national labs offer programs called Summer Undergraduate Lab Internships that are, in essence, exactly the same as REUs, but on a larger scale. Brookhaven’s physics internship program is the country’s largest, with around 200 interns present in June and July. The application cycle closes in January each year. Our physics department has a close connection at Brookhaven in Dr. Patrick Looney, chair of the Sustainable Energy Technologies department and expert in science policy. Thanks to his help, my mentor for the summer was Dr. Matthew Eisaman, a young gun studying solar cells in a state-of-the-art lab. My project covered the automation of a high-intensity laser setup for testing sample cells fabricated by the other interns in my group. The project was extremely well-organized, with lessons, a timeline, and full background readings and texts provided.

Housing was free and quite adequate. Brookhaven is fairly remote, but enough of the interns were local that I had a way to get around. Brookhaven offers a convenient shuttle service to the local Long Island Railroad station, which allowed me access to New York as well. I was stipended $500 per week before taxes. The program coordinators also organized social events for the interns (softball game vs. mentors, BBQ, trip to Great South Bay Music Festival), and having so many students around made it easy to find friends (though I was the youngest intern present). We were additionally treated to weekly lectures, a very useful science writing tutor, and some nice free stuff. Weather was sunny, and I rode a bike Brookhaven provided for me. In addition to solid internet, a game house and rec center were open for entertainment. A weekly shuttle ferried us to the local supermarket, and we cooked in the evenings. The
INFN-DOE Summer Exchange - Legnaro, Italy
Vittorio Loprinzo
Junior
I stumbled upon information about this program online while working at my previous internship, and everything about it immediately sounded fantastic. Basically, the program functions exactly the same way an REU or SULI internship does, but it takes place in Italy. The program website describes around 50 unique positions at labs and universities all around the country, and you apply for your top three. Only about a dozen students are selected each year. Most of the internships are in particle physics (and many involve collaborating with CERN), but there are a few condensed matter positions here and there. I was selected to study the materials physics behind neutron detection at Legnaro National Labs in Veneto, Italy.

Housing and lunch were free at my lab (this might not be the case everywhere), and I was stipended €3500 after Italian taxes. The lab was in a tiny town, but I was able to use buses and trains to travel around Italy on most weekends. I was the only undergraduate at the labs (though there were many graduate students and visiting scientists living with me in the guest houses), as the other American students in the program had been placed at other labs. The project was not nearly as well organized as SULIs and REUs in America, and at times it felt like they didn't know what to do with me. Italian labs are also not nearly as well funded and most American labs. However, the work was fine, travel amazing, and the drinking age well below my own, so I had a good time. Plus, good food is very cheap in Italy, and I ate like a king.

While many italians speak English quite well, I think it would be very difficult to make it through this internship without at least a working knowledge of italian. This was much more necessary for daily life than for lab work - most scientific words are cognates - so I'd advise you to have at least a couple courses under your belt before applying for this one.

Incidentally, this internship has probably the latest application cycle of any physics position out there, with applications unavailable until April and decisions released in May. If you've applied to other positions, you'd probably have to turn them down while still waiting for an answer about this one, but if you accidentally miss all the other deadlines, this could be your one last shot.

Johns Hopkins APL JHU Student Internship - Laurel, MD
Joseph Cleary
Junior
As a physics major, you should know about the Johns Hopkins Applied Physics Lab (APL), a separated industry R&D division of our university. APL offers several special intern programs for JHU students, as well as regular internships you would expect at a research lab. You will be placed with one or more regular employees and assist them in whatever projects they are working on. As the “Applied” suggests, these projects will probably be on the engineering side of things. You are not expected to come in as an expert on the projects you work on. As with any research, there will be a period where you have to come up to speed. But don’t be discouraged, as you will be an expert by the time you leave. APL works on other government and industry contracts, so it is a great place to get a look at what physicists outside of academia do.

Things to be aware of: You must be able to obtain a Department of Defense security clearance to work at APL. Also, APL is in Laurel, Maryland. For those of you unfamiliar with the region, this is about halfway between Baltimore and D.C. It is not possible to get there by public transportation. You will need to find someone else who is working there who has a car or get one yourself. This is usually not an issue as a large number of JHU students usually work there each year. Have fun on I-95.

Texas A&M REU - College Station, TX
Tarini Konchady
Sophomore

Eight students are selected every summer for this REU. The program has two main research focuses – science and instrumentation. The instrumentation students work in a team on a single project, while the science students work on separate projects under professors and/or graduate students. The application deadline is the beginning of February. If you’re a science student, you probably won’t know what you’re working on until a week or two before the program starts. The grand aim of the program is to have a poster to present at the university-wide poster session at the end of the summer.

The physics and astronomy departments at A&M were separate; this was a new development though; the astronomy department is only seven years old. However, the faculty’s research interests span a wide range of topics and the atmosphere was very friendly. Monday through Thursday mornings, the REU students met with some of the graduate students and faculty to discuss new astronomy and astrophysics papers that have been released that day. On Friday mornings, most of the department got together to discuss papers that had been released that week. This discussion was spearheaded by the graduate students and faculty. Additionally, faculty took turns giving talks about their research to the REU students over Friday lunch. The university observatory was opened to the REU students one night a week, and towards the end of the summer, the students were taken to McDonald Observatory for four nights of observing.
The stipend for the summer was $5000, housing was covered, and astronomy REU students were given a food allowance of $500 for the whole summer. College Station is relatively small but everything is very spread out. The most convenient way to get around would be by car. Alternatively, the university has a bike sharing service and a bus service.

Texas A&M also had events for REU students all across the university. There were weekly talks that cover research as a career, and graduate school. There was also a similar series of talks called the Summer Scholars program, which was directed at minorities. If you are a rising senior and part of an REU program at A&M, you have the option to try for early graduate admission – you would know of their decision by September or October of your senior year. However, this would lock you into A&M, much like early decision for undergrad. If you’re certain you want to attend A&M though, it's worth looking into.