Toward a PhD Degree in Physics

Jacobus Verbaarschot, Graduate Program Director

jacobus.verbaarschot@stonybrook.edu

Stony Brook University

Stony Brook, August 2014
Ph.D. Requirements

Placement Exam or Evaluation Interview
during orientation week

Core Courses
PHY 501, 505, 511
511, 512, 540

Find Advisor
Essential. Needed for oral exam and Ph.D. degree

Comprehensive Exam
Twice a year; must pass by the end of the second year

Required Courses
Three breadth courses, PHY 598, 598, 515 or 517

Thesis Research
Original work for the thesis

Oral Exam
Must be done by the end of the second year

Advancement to Candidacy
MAJOR STEP!

Review work with the thesis committee once a year

Write thesis according to the format of the graduate school.
File forms, watch deadlines

Defend Thesis
Thesis should be completed two weeks before the defense
Typical Course of PhD Degree

Year 1  Take courses and TA.
First Summer  Work in a Research Lab
Year 2  Start Research, Take courses in your specialty and TA.
        At the end of the second year all students should have an advisor.
Year 3  Spend all your time on research.
Year 4  Spend all your time on research. Most students author their first paper during this year.
Year 5  Start thinking about your dissertation. Many theory students get their PhD degree at the end of the fifth year.
Year 6  Most experimental students get their PhD degree during this year.
From the Guide:

If a student already successfully passed similar courses elsewhere a student fulfill the course requirements of one or more of these core courses by taking advanced graduate courses (subject to approval by an Advising Committee appointed by the Graduate Program Director). If that is not the case you can still skip these courses by a sufficiently good performance in the corresponding parts of a placement examination given at the beginning of each fall semester (2nd year students and beyond need permission from the Graduate Program Director).

The evaluations took place on Tuesday.

The placement will be next week.

Most students take the core course during their first year.
Tracks in the PhD program

In the Department of Physics and Astronomy we have four tracks:

- Physics Track
- Concentration in Astronomy
- Concentration in Physical Biology
- Concentration in Chemical Physics

The Physics Track is the default track. If you complete a Ph.D. in other tracks it will appear on your diploma.

Students in the Astronomy track have to take three astronomy courses instead of 2 physics breadth courses.

For Physical Biology the course sequence is quite different whereas for the Chemical Physics track the course requirements are the same as for Physics.
Main Difference Between Tracks

However, the main difference between tracks is the affiliation of your advisor. For the Astronomy track, he belong to the Astronomy Group. For the Track in Physical Biology, your advisor is affiliated with the Laufer Center, the Department of Physiology and Biophysics or Pharmacological Sciences. For the Chemical physics Track, she has the Department of Chemistry as her main affiliation.
Core Courses

Core Courses, these are required course unless you have passed the Placement exam in the subject

- PHY 501: Classical Mechanics
- PHY 505: Electricity and Magnetism (with recitation)
- PHY 511/512: Quantum Mechanics
- PHY 540: Statistical Mechanics
Other Required Courses

Breadth: Three advance courses in different fields
PHY 515: Graduate Laboratory – should be taken before the end of the second year, taking it in the third or second semester is recommended
Can be substituted by PHY 517 (Astronomy Lab Course)
PHY 598-9: Graduate Seminar
PHY 600: Two semesters of teaching
PHY 521-4: Students in the Astronomy Track should take three of the four Astronomy Courses
Breadth Requirement

Three advanced courses, in three different areas of physics, chosen from a list of courses and areas approved for this purpose. No more than one course from the 680 or 690 series can be used to fulfill this requirement.

Areas and Courses:

Astronomy: 521, 522, 523, 524, 683, 688
Atomic Physics: 565, 566, 690
Accelerator Physics: 554, 543, 564
Solid State Physics: 555, 556, 681
Nuclear Physics: 551, 684
Particle Physics: 552, 557, 612, 613, 686
Physical Biology: 558, 559, 687
Theoretical Physics: 541, 610, 611, 620, 621, 680, 681, 685
## Default Course Plan

**Default**

<table>
<thead>
<tr>
<th>First Semester</th>
<th>Second Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 501 (Classical Mechanics)</td>
<td>PHY 540 (Statistical Mechanics)</td>
</tr>
<tr>
<td>PHY 505 (Classical Electrodynamics)</td>
<td>PHY 515 (Graduate Lab)</td>
</tr>
<tr>
<td>PHY 511 (Quantum Mechanics I)</td>
<td>PHY 512 (Quantum Mechanics II)</td>
</tr>
<tr>
<td>PHY 598/9 (Graduate Seminar)</td>
<td>PHY 598/9 (Graduate Seminar)</td>
</tr>
<tr>
<td>PHY 600 (Teaching)</td>
<td>PHY 600 (Teaching)</td>
</tr>
<tr>
<td>PHY 698 (Colloquium)</td>
<td>PHY 698 (Colloquium)</td>
</tr>
</tbody>
</table>
## Course Plan for Astronomy Track

<table>
<thead>
<tr>
<th>First Semester</th>
<th>Second Semester</th>
<th>Third Semester</th>
<th>Fourth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 517 (Astronomy Lab)</td>
<td>PHY 521 (Stars)</td>
<td>PHY 524 (Cosmology)</td>
<td>PHY 523 (Galaxies)</td>
</tr>
<tr>
<td>PHY 501 (CM)</td>
<td>PHY 540 (SM)</td>
<td>PHY 511 (QM I)</td>
<td>PHY 512 (QM II)</td>
</tr>
<tr>
<td>PHY 505 (EM)</td>
<td>Elective</td>
<td>Other Courses</td>
<td></td>
</tr>
<tr>
<td>PHY 598/9 (Seminar)</td>
<td>PHY 598/9 (Seminar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 600 (Teaching)</td>
<td>PHY 600 (Teaching)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 698 (Colloquium)</td>
<td>PHY 698 (Colloquium)</td>
<td>PHY 698 (Colloquium)</td>
<td>PHY 698 (Colloquium)</td>
</tr>
</tbody>
</table>
Other Plans for Core Courses

Postponing Statistical Mechanics

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
<th>F2</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>501 (CM)</td>
<td></td>
<td>540 (SM)</td>
<td></td>
</tr>
<tr>
<td>505 (EM)</td>
<td>515 (Lab)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>511 (QM)</td>
<td>512 (QM)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Taking the Core Courses at a slower pace

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
<th>F2</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>501 (CM)</td>
<td>540 (SM)</td>
<td>511 (QM)</td>
<td>512 (QM)</td>
</tr>
<tr>
<td>505 (EM)</td>
<td>515 (Lab)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you did not have a proper undergraduate QM course, take our undergraduate QM course first (PHY 578 – renumbered as graduate course). This course does not count as credit towards your Ph.D. If you need to take an undergraduate courses in CM, EM or SM, then you can take are renumbered undergraduate courses PHY 573, PHY 571 and PHY 578, respectively.
# Course Plan for Advanced Students

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
<th>F2</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>501 (CM)</td>
<td>610 (QFT1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>541 (Adv SM)</td>
<td>620 (Gen Rel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>680 (Groups)</td>
<td>612 (Particle Physics)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>552 (Nuclear II)</td>
<td>515 (Graduate Lab)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>598 (Graduate Seminar)</td>
<td>599 (Graduate Seminar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 (TA)</td>
<td>600 (TA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Doing the required courses as soon as possible

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
<th>F2</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>541 (Adv SM)</td>
<td>540 (SM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>515 (Graduate Lab)</td>
<td>620 (Gen Rel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>580 (Groups)</td>
<td>610 (QFT1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>558 (Physical Biology)</td>
<td>551 (Nuclear Physic 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>598 (Graduate Seminar)</td>
<td>599 (Graduate Seminar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 (TA)</td>
<td>600 (TA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Course Requirements for Physical Biology

<table>
<thead>
<tr>
<th>Physics Track</th>
<th>Physical Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 505 (Electrodynamics)</td>
<td>PHY 505</td>
</tr>
<tr>
<td>PHY 511 (Quantum Mechanics)</td>
<td>PHY 511</td>
</tr>
<tr>
<td>PHY 540 (Statistical Mechanics)</td>
<td>PHY 540</td>
</tr>
<tr>
<td>PHY 600 (Teaching Practicum), two semesters</td>
<td>PHY 600, two semesters</td>
</tr>
<tr>
<td>PHY 501 (Classical Mechanics)</td>
<td>PHY 501 or PHY 512</td>
</tr>
<tr>
<td>PHY 512 (Quantum Mechanics)</td>
<td></td>
</tr>
<tr>
<td>PHY 515 (Methods of Experimental Physics)</td>
<td>Two semesters of PHY 584 (Lab Rotations)</td>
</tr>
<tr>
<td>PHY 598/599 (Graduate Seminar)</td>
<td>PHY 665 (Journal Club), 2 semesters</td>
</tr>
<tr>
<td>Two advanced courses</td>
<td>Two life science courses from an approved list</td>
</tr>
<tr>
<td></td>
<td>PHY 558 (Physical Biology)</td>
</tr>
<tr>
<td></td>
<td>PHY 559 (Biological Dynamics and Networks)</td>
</tr>
<tr>
<td></td>
<td>PHY 561 (Biology for Physical Scientists)</td>
</tr>
</tbody>
</table>
Master Program

- Master of Science Program in Instrumentation: Please contact Prof. Metcalf

- Master of Arts Program
  - No Thesis Option: 598 and 599 (Graduate Seminar)
    Passing 28 credits of graduate courses
    Passing the Comprehensive Exam at the Master level
  - Thesis option: 598 and 599 (Graduate Seminar)
    Graduate courses approved by the GPD
    A Master Thesis (with 10-25 research credits (580))

To be admitted to a PhD program, here or elsewhere, you have to do well in the courses and/or research.
Options for MA Degree

- Option that prepares you for employment outside academia

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>514 (Instruments)</td>
<td>518 (Synchrotron Radiation)</td>
</tr>
<tr>
<td>562 (Lasers)</td>
<td>565 (AMO)</td>
</tr>
<tr>
<td>515 (Graduate Lab)</td>
<td>595 (Thesis Research (6 credits))</td>
</tr>
<tr>
<td>598 (Graduate Seminar)</td>
<td>599 (Graduate Seminar)</td>
</tr>
<tr>
<td>Electives</td>
<td></td>
</tr>
</tbody>
</table>

During the Summer of the First year: Complete your Master Thesis. You also may be able to transfer up to 6 credits.
Options for MA Degree

- Option that prepares for transfer to a PhD program

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>501 (CM)</td>
<td>540 (SM)</td>
</tr>
<tr>
<td>505 (EM)</td>
<td>515 (Lab)</td>
</tr>
<tr>
<td>510 (QM)</td>
<td>512 (QM )</td>
</tr>
<tr>
<td>555 (Solid State)</td>
<td>565 (AMO)</td>
</tr>
<tr>
<td>598 (Graduate Seminar)</td>
<td>599 (Graduate Seminar)</td>
</tr>
<tr>
<td>Electives</td>
<td>Electives</td>
</tr>
</tbody>
</table>

Try to work with a research group during the Summer
# Option for Advanced MA Degree

Option for advanced students

<table>
<thead>
<tr>
<th>F1</th>
<th>S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>501 (CM)</td>
<td>610 (QFT1)</td>
</tr>
<tr>
<td>580 (Groups)</td>
<td>622 (String Theory)</td>
</tr>
<tr>
<td>622 (String Theory)</td>
<td>620 (General Relativity)</td>
</tr>
<tr>
<td>541 (Adv SM)</td>
<td>680 (Quantum Computing)</td>
</tr>
<tr>
<td>598 (Graduate Seminar)</td>
<td>599 (Graduate Seminar)</td>
</tr>
<tr>
<td>Electives</td>
<td>Electives</td>
</tr>
</tbody>
</table>

Do research during the Summer
Course Evaluations

- Since three years course evaluations are electronic
- Please complete course evaluations. This helps faculty to improve their course and helps students to select courses
- If you teach please encourage your students to complete the evaluations, for the same reasons
- To see course evaluations go to https://it.stonybrook.edu/it-guides/students
Setting up a Proxy Server

- `ssh -l yourstonybrookaccount -D 9501 graduat.physics.sunysb.edu`
- Will ask for a password
- One your home computer open preferences of Firefox
- Go to Connection Setting
- Select Manual Proxy Configuration
- for SOCKS Host type in 127.0.0.1
- For portnumber type 9501 (same as above)
- Choose Socks v5
- Click ok
Comprehensive Exam: This exam is offered twice a year. Most students take it in their second or third semester, but you can also take it next week. It covers the core courses and astrophysics. Each subject can be passed separately. A good source for the material of this exam is [http://mysbfiles.stonybrook.edu/~klikharev/EGP/](http://mysbfiles.stonybrook.edu/~klikharev/EGP/)

Placement Exam: This is the same exam as the comprehensive exam but student have to pass all three problems in a given subject while the passing level is higher.

Oral Exam: The oral exam consists of a presentation of some approved and interesting topic in physics or astronomy to a committee of three faculty members and should be prepared with the guidance of one of them. Usually that person is going to be your advisor.
What If You Fail the Exam

Placement Exam: No problem, just take the course(s)

Fail the Course (less than a B): Repeat the course

Fail the Course for a second time: Petition for an oral exam or to do the placement exam. This requires approval of the Graduate Program Director.

The Comprehensive Exam: Take it again.

The Comprehensive Exam at the beginning of the fifth semester: Make sure you have an advisor; She may argue your case before the faculty to set up a special oral exam.
Research

Experimental/Observational

Astronomy (Exoplanets, Neutron Stars)
Atomic, molecular and optical physics (Cold Atoms, Ultrafast Lasers)
Condensed matter experiment (Graphene, Electromagnetic Materials)
High energy experiment (CERN-Atlas, Fermilab, Neutrino)
Relativistic Heavy Ion Physics (RHIC)

Theoretical

Astrophysics (computational, neutron stars)
Atomic physics (Bose Einstein Condensation)
Condensed matter (computational, strongly correlated electrons)
Nuclear theory (QCD, Quark Gluon Plasma, Random Matrix Theory)
YITP (particle theory, statistical mechanics, string theory)
Simons Institute (mathematical physics, string theory)
Laufer Center (physical biology, protein structure)
Research Outside the Department

Research at Brookhaven National Laboratory

Accelerator and beam physics
NSLS-II – may work before you finish
Lattice QCD / nuclear theory
Condensed matter theory

Marine Sciences

Climate Studies
Atmospheric Physics
How to Find an Advisor, Financial Support

Start early. Try to get a summer job after the first year

Talk to professors of the courses you are taking

Watch email / bulletin board postings about research opportunities

Go to Friday afternoon seminars

Get good grades in particular in the subject you are interested in

If possible, get into a research group by the end of the first year

If you have more than one option for advisor consider the following:

  - The career path of former graduates of the group
  - How long does it take to get a degree
  - What is the stipend
Course Registration

Most of you will register for the following courses:

- PHY 501, Classical Mechanics (3 credits)
- PHY 505, Electromagnetism (3 credits)
- PHY 511, Quantum Mechanics (3 credits)
- PHY 598/599, Graduate Seminar (1 credit)
- PHY 600, Teaching Practicum (1 credit) (this is your TA assignment and is not a real class)
- PHY 698, Colloquium (1 credit) (you are strongly urged to come to the colloquium each week).

Exceptions:

- Astronomers: take PHY 521 (Stars)
- Those who passed the placement exam or got waivers from the evaluation committee are not required to take the core courses
Other Courses This Semester

PHY 514: Research Instruments
PHY 515: Methods of Experimental Research (aka Graduate Lab)
PHY 517: Astronomical Techniques
PHY 541: Advanced Statistical Mechanics (breadth)
PHY 542: Accelerator Physics Lab
PHY 555: Solid State I (breadth)
PHY 552: Nuclear Physics II (breadth)
PHY 566: Quantum Electronics II (breadth)
PHY 613: Topics in Advanced Particle Physics
PHY 622: String Theory
PHY 655: Advanced Graduate Seminar
PHY 680-1: Group Theory
PHY 687: Topics in Physical Biology
Remedial Courses

PHY 571, PHY 573, PHY 576, PHY 578 are renumbered undergraduate courses and do not count as credit for an Master or Ph.D. degree. You may want to take these courses if you did not have an undergraduate course in these subjects. They count as credit, tough, for an MAT (Master of Arts in Teaching) degree.
The university classifies graduate students according to their G-status

**G1:** First year graduate student with less than 24 graduate credit hours, who is enrolled in a Master's degree program.

**G2:** Advanced graduate student with more than 24 graduate credits, who is enrolled in Master’s degree program.

**G3:** First year graduate student with less than 24 graduate credits, who is enrolled in a Ph.D. program.

**G4:** Advanced graduate student with more than 24 graduate credits, who is enrolled in a Ph.D. degree program.

**G5:** Advanced graduate student in a Ph.D. program who is advanced to candidacy by the first day of classes of a semester.

The conversion from G1 to G2 is automatic after completion of more than 24 graduate credits at Stony Brook. Same for the conversion from G3 to G4. Conversion from G4 to G5 is done by the graduate school after recommendation from us.
Advancement to Candidacy

A student is advanced to candidacy if all graduate school and departmental requirements other than the dissertation are completed. The Graduate Program Director sends a written notice to the Dean of the Graduate School to recommend advancement to candidacy which is then granted by the Dean of the Graduate School. Students must advance to candidacy at least one year before defending their thesis.
## Summary and Credits

<table>
<thead>
<tr>
<th>Status</th>
<th>Credit earned</th>
<th>Degree sought</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>&lt; 24</td>
<td>Master</td>
<td>12-18</td>
</tr>
<tr>
<td>G2</td>
<td>≥ 24</td>
<td>Master</td>
<td>9</td>
</tr>
<tr>
<td>G3</td>
<td>&lt; 24</td>
<td>Ph.D.</td>
<td>12-18</td>
</tr>
<tr>
<td>G4</td>
<td>≥24</td>
<td>Ph.D.</td>
<td>9</td>
</tr>
<tr>
<td>G5</td>
<td>all reqs</td>
<td>Ph.D.</td>
<td>9</td>
</tr>
</tbody>
</table>

Many courses are offered with variable credits (see graduate bulletin). By adjusting credits, you can get the right total number of credits.

Swapping courses: change registration between courses with an equal number of credits.
Courses with Zero Credits

If a course is offered for 0-3 credits, the workload is independent of the number of credits: Zero credit does not mean zero work.

By taking courses with zero credit, the department knows that you have fulfilled the requirement.
If you take courses outside the department, you need permission from the graduate program director.

After having advanced to candidacy you should register for 9 credits in PHY 699 (research). Explicit permission to register for others courses requires permission by the graduate program director.
Deadlines

August 24: You must have registered for at least one credit by midnight of this date – otherwise it will cost you real money.

August 25: First day of classes.

August 25-28: 4-7 pm but Tuesday 7-10 pm, Comprehensive and Placement Exam in S 240.

August 31: Last day to drop classes – if you exceed the total number of credits you could be liable for tuition. You still can add or swap classes.

September 1-2: Labor Day Holiday.

September tba: Department Picnic, 5-8 pm on West Meadow Beach

September 9: Last day to drop classes without a W

September 9: Last day to swap classes

September 9: Last day to drop classes

September 16: Last day to add classes

See: [http://ws.cc.stonybrook.edu/registrar/calendar-academic.shtml](http://ws.cc.stonybrook.edu/registrar/calendar-academic.shtml) for a complete academic calendar.
What Does it Take to Become a First Class Physicist or Astronomer?

- Think independently
- Step back to analyze the big picture
- Don’t accept any ‘truth’ from any authority unless you have verified it yourself
- Question everything
- Work on hard problems