

PHY251 Modern Physics Spring 2017

Lecture time: 2:30-3:50pm Tues Thurs, Location: Physics Room 118
Instructor: Tzu-Chieh Wei <tzu-chieh.wei[at]stonybrook[dot]edu>
Office hour: TBA

Recitation Instructors:

Prof. Dmitri Tsybychev <dmitri.tsybychev[at]stonybrook[dot]edu>

Recitation time: Tu 10:00AM - 10:53AM, Location: Physics Room 112

Prof. Navid Vafaei-Najafabadi, <navid.vafaei-najafabadi[at]stonybrook[dot]edu>

Recitation time: Th 10:00AM - 10:53AM, Location: Physics Room 112

Consult recitation instructors for their own office hours

Grader: **Charles Shugert** <charles.shugert[at]stonybrook[dot]edu>

Course description:

A *survey* of the major physics theories of the 20th century (relativity and quantum mechanics) and their impact on most areas of physics. It introduces the special theory of relativity, the concepts of quantum and wave-particle duality, Schroedinger's wave equation, and other fundamentals of quantum theory as they apply to nuclei, atoms, molecules, and solids. The Laboratory component, PHY 252 (Modern Physics Laboratory), must be taken concurrently; a common grade for both courses will be assigned. Three hours lecture and one hour recitation per week, as well as laboratory work.

Prerequisite: PHY 122/124, or PHY 126 and 127, or PHY 132 or PHY 142; and PHY 134; C or higher in MAT 126 or 132 or 142 or 171 or AMS 161

Pre- or Corequisite: MAT 203 or MAT 205 or AMS 261 or MAT 307 Corequisite: PHY 252

We will cover quantum mechanics to the extent that we need for other parts of this course. PHY307 Physical and Mathematical Foundations of Quantum Mechanics is recommended after you finish PHY251. Quantum mechanics will be treated more rigorously and extensively in [PHY308 Quantum Physics](#). Other more specialized courses you may want to consider in the future after finishing this course: PHY408 Relativity, PHY431 Nuclear and Particle Physics, PHY451 Quantum Electronics, PHY452 Lasers, PHY472 Solid State Physics, and AST347 Cosmology.

[PHY252 Modern Physics Laboratory](#) (must be taken concurrently) is administered by [Prof. Matthew Dawber](#) and has a [website here](#).

Required Textbook :

There are many textbooks on Modern Physics. The one that I shall use as the main one is

Modern Physics for Scientists and Engineers by John Taylor, Chris Zafiratos, and Michael A. Dubson, (2nd edition) published by University Science Books or previously by Addison-Wesley (2nd edition)

[Science/Engineering Library has the latter copy: use PHY251 as course name in library reserve search at

<http://library.stonybrook.edu/services/course-reserves/>; the reserved copy is two-hour loan and would be held behind the main desk in the North Reading Room]

Recommended Textbooks:

There are a few textbooks that will complement the above Taylor, Zafiratos and Dubson in styles and materials, including

1. *Modern Physics for Scientists and Engineers* 2nd Edition by John Morrison (which covers fewer materials, but slightly more advanced than Taylor et al.)

This book has a [website](#) that contains applets, which can be downloaded or used online. Morrison also discusses simulations from PhET developed at the University of Colorado; see [here for simulations of quantum phenomena](#). (Morrison's book is entirely optional.)

2. *The Feynman Lectures on Physics, Vol. 3* [optional] ([which can be read online here](#)): the classic Feynman Lectures are highly recommended irregardless.

There are other Modern Physics textbooks similar in style and material selection to Taylor et al., including Tipler and Llewellyn (which nicely includes Astrophysics and Cosmology), Thornton and Rex (which also includes Astrophysics and Cosmology), Serway and Moses (Cosmology is Web only), Eisberg and Resnick (classic but a bit outdated), etc

3. *Special Relativity*. If you are interested in reading more about relativity, there is a recent book by Dr. David Morin (Harvard University): [Special Relativity - For the Enthusiastic Beginner \(David Morin\)](#)

Recommended Documentary (not much science background assumed):

I. [The Fabric of the Cosmos](#) which includes:

Episode (1) [What is space?](#)

Episode (2) [The illusion of time](#)

Episode (3) [Quantum leap](#)

Episode (4) [Universe or multiverse?](#)

II. [The Mystery of Matter: Search for the Elements](#) (which was the 37th Annual News & Documentary Emmy® Awards Winner - Outstanding Lighting Direction and Scenic Design):

Episode (1) [Out of thin air](#)

Episode (2) [Unruly elements](#)

Episode (3) [Into the atom](#)

Learning outcomes: After this course, you will be able to have good understanding of modern physics, to do simple estimates and calculations about the atoms, nuclei, light, and acquire basic knowledge about atomic physics, statistical physics, solid state physics, nuclear and elementary particles, and the universe. You will also have better appreciation of the many scientific details about important discoveries (such as in the above documentaries).

Grades: (tentative) Note that (1) PHY252 (Modern Physics Laboratory) must be taken concurrently and it will be included as part of the grade for PHY251 and (2) Recitations are an integral part of this course and must be taken as well

Final Grading is based on:

Homework (+class participation, quizzes, etc): 10%

Recitations (participation and quizzes): 15%

Midterms: 30% (15% each)

Final Exam: 20%

Lab (PHY252): 25%

For example, on a scale of 0 to 100, the letter grade is assigned approximately, A: 90-100, A-: 86-89.99, B+: 80-85.99, B: 76-79.99, B-: 70-75.99, C+: 66-69.99, C: 60-65.99, C-: 56-59.99, and so on.

Homework problems may involve use of computer; you can use any programs you prefer, such as C/C++, Fortran, Matlab, Mathematica, etc. Intel offers [Free Software Tools](#) for students. University also has licenses for Matlab and Mathematica and these softwares are available at [SINC sites](#).

Homework policy: no late homework (must be turned in on the due day in class; exception must be requested two days or earlier before deadline; if you cannot bring homework to class, you can scan it and email it to the instructor). Grading of homework is based on overall effort and 3 selected problems. (e.g. say there are 10pts for one homework set: 3 problems are graded and each worth 2pts max, the effort of the remaining will be checked and 4pts max can be awarded)

Recitations: homework problems will be discussed in recitations; there is also a quiz from time to time (see below) based on homework problems

Exams: formula sheet of one page of letter size is allowed (only formulas, not solutions to any problems); your solutions should present clear logic, cannot simply copy formulas

Laboratory schedule is posted [here](#)

Topics to be covered and tentative syllabus

(This is a tentative syllabus. Exam dates and due dates may change. Check later for update.)

The syllabus will evolve as classes move on. Reading of sections by Taylor, Zafiratos and Dubson will be listed and they are required.

1. Overview and special theory of relativity:

<reading: 1.1-1.14, 2.1-2.10>

(week 1) [1/24,1/26]

(week 2) [1/31,2/2]

2. Experiments and ideas (wave-particle duality, uncertainty principle, quantization, etc.) leading to quantum theory:

<reading: 3.1-3.12, 4.1-4.7, 5.1-5.9, 6.1-6.10>

(week 3) [2/7,2/9] *

(week 4) [2/14,2/19]*

3. Quantum mechanics in 1D:

<reading: 7.1-7.8>
(week 5) [2/21,2/23] *

4. Quantum mechanics in 3D & atomic energy levels:

<reading: 8.1-8.10, 5.1-5.9>
(week 6) [2/28, 3/2] **In-class midterm exam I: 3/2**
(week 7) [3/7, 3/9]
(week 8) Spring recess

5. Electron spin, multi-electron atoms, periodic table:

<reading: 9.1-9.8, 10.1-10.8>
(week 9) [3/21,3/23]*

6. Atomic transitions and radiation:

<reading: 11.1-11.9>
(week 10) [3/28,3/30]*

7. Statistical physics:

<reading: 15.1-15.9>
(week 11) [4/4,4/6]*

8. Solid-state physics:

<reading: 13.1-13.12, 14.1-14.8>
(week 12) [4/11,4/13] **In-class midterm exam II: 4/13**
(week 13) [4/18,4/20]

9. Structure of atomic nuclei and radioactivity, particle physics:

<reading: 16.1-16.8, 17.1-17.5, 18.1-18.10>
(week 14) [4/25,4/27]*
(week 15) [5/2,5/4] *

Additional topics such as cosmology and quantum information and computation might be discussed if time permits.

* indicates the week where there is a *quiz during recitation*, the quiz will be based on previous homework (i.e. similar problems) so you should understand all the homework problems, even after you turn them in.

Final exam: TBA; see [Registrar](#) (11:15am-1:45pm Monday May 15, 2017)

Recommended additional reading and viewing:

1. [Special Relativity in a Nutshell](#)
2. [Einstein's Big Idea](#)
3. [A Trip Through Spacetime](#)
4. [Putting Relativity to the Test](#)
5. [Inside Einstein's Mind](#)
6. [The Amazing Atomic Clock](#)
7. [The Fabric of the Cosmos](#)
8. [Hunting the Elements](#)
9. [The Mystery of Matter: Search for the Elements](#)
10. [Does Antimatter Fall Up or Down?](#)
11. [Origins: Back to the Beginning](#)
12. [Big Bang Machine](#)
13. [Relativity and the Cosmos](#)
14. [How Big Is the Universe?](#)
15. [A Quantum Leap in Computing](#)

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Announcement, Update and Additional Information

More will be posted to Blackboard.stonybrook.edu

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For your information:

A brief guide to 'Student Success Resources' that are available on our campus:

<https://ucolleges.stonybrook.edu/links/academic-success-resources.pdf>

Americans with Disabilities Act:

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services (631) 632-6748. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students requiring emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information, go to the following web site <http://studentaffairs.stonybrook.edu/dss/>

Academic Integrity:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's

work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at <http://www.stonybrook.edu/uaa/academicjudiciary/>

Critical Incident Management:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Electronic Communication:

Email to your University email account is an important way of communicating with you for this course. For most students the email address is 'firstname.lastname@stonybrook.edu', and the account can be accessed here: <http://www.stonybrook.edu/mycloud>. *It is your responsibility to read your email received at this account.*

For instructions about how to verify your University email address see this:

<http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo> . You can set up email forwarding using instructions here: <http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail> . If you choose to forward your University email to another account, we are not responsible for any undeliverable messages.

Religious Observances:

See the policy statement regarding religious holidays at <http://www.stonybrook.edu/registrar/forms/RelHolPol%20081612%20cr.pdf> Students are expected to notify the course professors by email of their intention to take time out for religious observance. This should be done as soon as possible but definitely before the end of the 'add/drop' period. At that time they can discuss with the instructor(s) how they will be able to make up the work covered.

Instructional/Student Responsibilities: the University Senate's Undergraduate Council updated The University's statement of Minimal Instruction and Student Responsibilities in Fall 2008. Also listed are the Minimal Undergraduate Student Responsibilities. Both statements may be found in the Academic Policies and Regulations section of the on-line Undergraduate Bulletin:

http://sb.cc.stonybrook.edu/bulletin/current/policiesandregulations/policies_expectations/min_instructional_student_resp.php.

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