Natural Science I: Einstein’s Universe (The Dark Universe)  
CORE-UA.204.001

Fall 2014  
Lecture: Meyer 121
Lab: Silver 203

Tuesday and Thursday
11:00 a.m. – 12:15 p.m.
Instructor: Prof. Neal Weiner
Office: Meyer 504
Office Phone: (212) 992-8784
E-mail: weiner.academic@gmail.com
Office Hour: T 12:30p.m.- 1:30 p.m., or by appointment

Lab Section  
Day  
Time
2  Monday  
9:00 – 10:40 a.m.
3  Monday  
11:00 a.m. – 12:40 p.m.
4  Monday  
1:00 – 2:40 p.m.
5  Monday  
3:00 – 4:40 p.m.
6  Monday  
5:00 – 6:40 p.m.
7  Tuesday  
9:00 – 10:40 a.m.

Course Description

This course attempts to introduce the most important concepts of 20th century physics, and what may be some exciting questions for 21st century physics. We will use three of Einstein’s great discoveries as the jumping off point for our discussion: the photoelectric effect, special relativity and general relativity. The photoelectric effect was instrumental in the development of atomic theory; special relativity changed our notions of space, time and energy. In particular, the famous E=mc^2 is the basis for our entire knowledge of stars and their evolution. General relativity changed our notions of gravity, and allowed the possibility of strange objects like black holes. Together these ideas have also changed our notions of how the universe is changing and its future. Along the way, we will also encounter the mysterious dark matter and dark energy, seen only through their gravitational interaction.

Course Objectives

• Learn how to absorb qualitative information about a variety of science topics and discuss it,
• See how we understand the natural world through observation, experimentation, and theory.
• Show how light is a messenger carrying information about the cosmos.
• Understand how the finite speed of light has dramatic implications for our concepts of time and space.
• Understand how to make measurements of the distant universe, including distances and motions
• Understand how the sun and other stars generate energy.
• See how stars form and evolve into white dwarfs, neutron stars and black holes.
• To understand what black holes are, what evidence there is for them.
• Look at the evidence for dark matter, and understand what it might be
• Understand the expansion of the universe, and the evidence for dark energy
• Provide an overview of the big bang theory, and the imprints of the early universe in the leftover radiation from the big bang.

Online resources

This course will utilize various online resources for the distribution of class material, information and schedule updates, and so forth. The core materials and announcements will be available on the NYU Classes site. However, I like to complement the class with some video, which will be posted on youtube. I’ll distribute links on NYU classes, but I will also post all relevant announcements at the class tumblr quarksandcosmos.tumblr.com, a facebook site Einstein's Universe - Fall 2014 NYU, and a
twitter account @profnwclass.

**Class Web Site**
A NYU Classes site for this class will exist and will be accessible through your NYUHome account. You must have an active NYU email account to access the site.

**Course Texts**
There is no single book that covers what I want to, hence the two texts. Older versions should be fine, although I won’t confirm any changes in section/chapter numbers. I will also have at least two copies on reserve in the library.

**Lectures**
Lectures are to help you learn the material, clarify what you are responsible for and to help you succeed on exams. Questions handed out each lecture and will form the basis of what you are responsible for from our twice-weekly meetings. Some of these questions are answered in your books, but all will be discussed in class. A given lecture sheet will be available on the day it is discussed, and will be available in class until it is posted online (usually a week after the lecture).

**NY Times readings**
A major goal of this course is to expose you to the wealth of research that is going on. To this end, you will be required to submit weekly three-paragraph summaries of one article (any article) in the NY Times science section. These will be submitted via email to your TA, as well as to weiner.academic@gmail.com. As described in the assignment on the blackboard page, all emails should have a subject line

Subject: NYT - Title of article

This is to help make sure they get recorded. *The first NYT assignment is due Sept 12 at 5pm.*

**Course Examinations**
The examinations will be based on (1) the lecture questions and text material, (2) exercises assigned in class, and (3) material covered in lab sections.

We will have two exams, in a multiple choice format. For exams, you will need to bring a calculator (not a phone). The midterm will focus on detailed aspects of the course. The cumulative nature of the final exam will be reflected in concepts from the mid-term exam that were the subject of those questions that had the most incorrect responses. The final exam will be cumulative with a design to test you on concepts from the mid-term exam that the most students had trouble with.

**Examination Schedule and Course Grade**

<table>
<thead>
<tr>
<th>Examination</th>
<th>Percentage</th>
<th>Date</th>
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<tbody>
<tr>
<td>Midterm examination (in Meyer 121):</td>
<td>20%</td>
<td>Tuesday, October 28 in class</td>
</tr>
<tr>
<td>NY Times summaries</td>
<td>10%</td>
<td>Due Fridays, 5PM (9/12 start)</td>
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<tr>
<td>Laboratory:</td>
<td>40%</td>
<td>Weekly (9/8 start)</td>
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<tr>
<td>Final examination (in Meyer 121):</td>
<td>30%</td>
<td>Tuesday, December 16, 10-11:50 am</td>
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Homework
Homework assignments will be given out in class and posted online by the end of the week for those who missed class. Homework assignments are to help you understand the material and to prepare you for course examinations, but are not explicitly graded, except when specified. In those cases, it will be handed in with your lab the week following their assignment and will constitute 1 point out of 10 of that week’s lab score.

Laboratory Sessions
These weekly sessions are an important part of the course. You must be registered for one lab section, which will meet in Silver 203. You will have to submit a lab report for each experiment performed. The lab report has to include answers to all questions and any data you may have collected. Most lab reports should be completable within the lab period, however you will have no more than five days to submit the final report if you cannot do so in the lab session. The laboratory sessions will be held in Silver 203 and will begin September 8. They will be devoted to

1. Doing experiments described in your laboratory manual.
2. Discussing the homework problems.
3. Going over questions from class.

Attendance The lab instructor will deduct points from your lab grade for arriving late or leaving early.

Absence Policy Excused absences will only be given in the case of illness (with a doctor’s note) or observation of a religious holiday. You must notify your lab instructor in advance in writing if you miss a lab due to religious reasons, this must be done in the first two weeks of the semester. All other absences will be considered unexcused and will result in a lab grade of zero. You cannot make up a lab by attending a laboratory session that you are not registered for unless previously authorized.

Late Assignments Late assignments will be penalized for each day late (excluding weekends). If you wish to submit a late lab report you must do so only at your laboratory instructor’s office.

Late NY Times summaries NY Times summaries will not be accepted late for any reason other than illness, supported by a doctors note.

Lab Instructors Each lab instructor will hold a weekly office hour or be available by appointment where you can discuss lecture and laboratory material. Office locations and office hour schedule will be announced in lab.

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<tr>
<th>Fang-Yi Chu</th>
<th>Aspee Chowdhury</th>
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<td>Hongliang Liu</td>
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Missed Exams

There are no make-up exams for students who miss the mid-term exam. If you miss the midterm because of illness, you must contact Prof. Weiner by phone or email before the start of the exam and follow up with a doctor’s note. If you miss an examination, for a valid reason (illness, injury or family emergency), your grade will be based on the following allocations:

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<tbody>
<tr>
<td>Midterm</td>
<td>20%</td>
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<tr>
<td>NY Times:</td>
<td>10%</td>
<td>10%</td>
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<tr>
<td>Laboratory:</td>
<td>40%</td>
<td>40%</td>
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<tr>
<td>Final examination (cumulative):</td>
<td>30%</td>
<td>50%</td>
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Final Exam A make-up for the final examination will be given under truly exceptional circumstances, which must be discussed with Prof. Weiner before the examination. A doctor’s note must be provided in the case of illness. In this case a grade of incomplete will be assigned and the make-up will entail taking the final exam for the next offering this course, which is no sooner than Spring 2015. Please avoid making travel plans before the date of the final exam. No alternative date for the final examination will be offered before the end of the Fall 2014 semester.

Religious Holidays If you will be absent for a religious holiday during the semester, you must inform your lab instructor and Prof. Weiner in the first two weeks of the semester.
Tentative Weekly Schedule of Topics and Laboratories

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture Topic</th>
<th>Reading</th>
<th>Weekly Lab</th>
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<tbody>
<tr>
<td>T Sept 2</td>
<td>Overview: Science and the Universe</td>
<td>TBA</td>
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<td>Th Sept 4</td>
<td>What is light?</td>
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<td>T Sept 9</td>
<td>How we see the Universe</td>
<td>Mathematics Review</td>
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<td>Th Sept 11</td>
<td>Blackbodies and temperature</td>
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<td>T Sept 16</td>
<td>Spectroscopy, atomic structure, the photoelectric effect</td>
<td>Young’s experiment</td>
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<td>Th Sept 18</td>
<td>Thermal radiation and the Doppler effect</td>
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<tr>
<td>T Sept 23</td>
<td>Spectral Line Analysis</td>
<td>Parallax</td>
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<td>Th Sept 25</td>
<td>Measuring the universe: parallax, standard candles, Kepler’s laws</td>
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<tr>
<td>T Sept 30</td>
<td>HR diagrams and stellar evolution</td>
<td>Photoelectric effect</td>
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<td>Th Oct 2</td>
<td>$E=mc$</td>
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<td>T Oct 7</td>
<td>Evolution of solar mass stars</td>
<td>Spectroscopy</td>
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<tr>
<td>Th Oct 9</td>
<td>Evolution of super-solar mass stars</td>
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<td>T Oct 14</td>
<td><strong>Fall Recess No class</strong></td>
<td>No lab this week</td>
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<td>Th Oct 16</td>
<td>Pulsars, neutron stars</td>
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<tr>
<td>T Oct 21</td>
<td>Black Holes, part 1</td>
<td>Midterm Exam Review</td>
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<tr>
<td>Th Oct 23</td>
<td>Michelson-Morely and a finite speed of light</td>
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<td>T Oct 28</td>
<td><strong>Midterm Exam 1</strong></td>
<td>Kinematics</td>
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<td>Th Oct 30</td>
<td>Length contraction, time dilation and the twin paradox</td>
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<td>T Nov 4</td>
<td>The equivalence principle and general relativity</td>
<td>Relativity Engine 1</td>
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<td>Th Nov 6</td>
<td>Gravity and warped spacetime</td>
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<tr>
<td>T Nov 11</td>
<td>Black Holes (part 2)</td>
<td>Relativity Engine 2</td>
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<td>Th Nov 13</td>
<td>The Structure of the Universe</td>
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<td>T Nov 18</td>
<td>Probing the universe with gravity: dark matter</td>
<td>Principle of Equivalence</td>
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<td>Th Nov 20</td>
<td>General relativity and the universe: Hubble’s law</td>
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<td>T Nov 25</td>
<td>Dark energy, supernovae and the accelerating universe</td>
<td>Redshift</td>
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<td>Th Nov 27</td>
<td><strong>Thanksgiving No Class</strong></td>
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<tr>
<td>T Dec 2</td>
<td>The Big Bang and CMBR</td>
<td>Hubble’s Law</td>
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<td>Th Dec 4</td>
<td>Inflation and “before” the Big Bang</td>
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<tr>
<td>T Dec 9</td>
<td>String theory and extra dimensions</td>
<td>Final Exam Review</td>
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<tr>
<td>Th Dec 11</td>
<td>The multiverse and other speculations</td>
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Tuesday, Dec 16
Final Exam in Meyer 121
10:00 to 11:50 a.m.
Frequently Asked Questions

Q: What email address should I use to contact you?
A: Use weiner.academic@gmail.com. My nyu email address generally receives ~100+ emails/day and so lots of emails got lost in the noise. If you use this gmail address, I can go back and check that I’ve responded to you. More to the point - if you use the NYU email, chances are 50/50 I’ll get back to you, but if you use this email, I can be almost certain not to miss it.

Q: Why do we need to put NYT in the subject header of our NYT emails?
A: This allows me to separate out the non-NYT email so I can again make sure I’m not missing important class emails.

Q: I missed my lab because of sickness, can I make it up?
A: No. The lab stations are disassembled every week and all labs are full, so there are no opportunities to make up labs. If you miss a lab, provide your TA and me with a doctor’s note and that zero will not be counted against you.

Q: I missed a lab or a test because I was sick, but didn’t get a doctor’s note. Can I still have that lab not counted?
A: No. If you are too sick to be in class, that’s very sick, extremely sick, even, your-parents-would-want-you-to-see-a-doctor sick, and you should see a doctor.

Q: I will miss a lab or labs due to religious holidays. Can I make it up?
A: You’ll either be able to make it up or you’ll be excused from it if that’s not possible. However, you must notify me in the first two weeks of the semester (so, by Sept 14) in order to plan.

Q: I missed a lab due to religious holidays! Can I make it up?
A: Did you notify me about it in the first two weeks of the semester?

Q: I missed the midterm, can I make it up?
A: No. If you have a note from a doctor, the final will have added importance. If you have no note, you will receive a zero.

Q: I missed the final, can I make it up this semester?
A: No. If you have a note from a doctor, then you will have the opportunity to take the final from the next time this course is offered in the Spring or next Fall. There will be no makeups this semester. That includes showing up or emailing later in the day of the final.
Q: I’m going to Aruba on the day before the midterm/final. It’s going to be so sunny and warm. Can I take the test early?  
A: Nope. Sorry.

Q: I have special needs for test taking, which the university if aware of. What should I do?  
A: No problem. Please contact me directly and we’ll arrange this.

Q: Can I use a previous year’s textbook?  
A: If it’s the same book as for this class, it will probably be similar, but I will be using this year’s textbook, and I won’t check to see if the material is used in earlier years’ books. I would imagine it will be fine, though.

Q: Do I need to know all the material from the book?  
A: Tests are based upon lectures, labs, and HW. Some material in the lecture will not be found in the book. Some material will come from additional web resources or handouts. However, what of this you should know is what I cover in class, thus the best resources for what you need to know are the class lecture sheets, your labs, and your HWs.

Q: I want to change my lab section. Can I?  
A: I don’t actually handle such changes. Contact the MAP/CORE office and they’ll let you know what can be done.

Q: Will you post the answers to the lecture sheets online?  
A: Nope, but I or your TAs will happily go over any lecture sheet in office hours should you miss class.