

PHYS 3313 – Section 001

Lecture #2

Wednesday, Aug. 28, 2013

Dr. Jaehoon Yu

- Class Organization and Various Info.
- Classical Physics
- Kinetic Theory of Gas
- Concept of Waves and Particles



Announcements

- Reading assignment #1:
 - Review Appendices 1, 2 and 9
 - Read and follow through Appendices 3, 5, 6 and 7 by Tuesday, Sept. 3
 - There will be a quiz next Wednesday, Sept. 4, on this reading assignment
- A faculty research expo today at 4pm, SH101
- A National Academy of Sciences member, Dr. David Nygren, will give a colloquium at 4:00pm, Wednesday, Nov. 6
 - Required attendance!
 - Triple extra credit points!!



Physics Department
The University of Texas at Arlington
COLLOQUIUM

Physics Faculty Research Expo #1

Wednesday August 28, 2013
4:00p.m. Rm. 101SH

SPEAKERS:

Dr. Andrew White

"High Energy Physics from the LHC to the ILC"

Dr. Jaehoon Yu

"From Higgs to Dark Matter Beams"

Dr. Ping Liu

"Research in nanoscale magnets."

Dr. Kaushik De

"Life after the Higgs"

Dr. Samarendra Mohanty

"Neurophotonic- Physical cues for neuronal guidance"

Refreshments will be served at 3:30 p.m. in the Physics Library

Special Project #1

1. Compute the electric force between the two protons separate the farthest in an intact U^{238} nucleus. Use the actual size of the U^{238} nucleus. (10 points)
 2. Compute the gravitational force between the two protons separate the farthest in an intact U^{238} nucleus. (10 points)
 3. Express the electric force in #1 above in terms of the gravitational force in #2. (5 points)
- You must look up the mass of the proton, actual size of the U^{238} nucleus, etc, and clearly write them on your project report
 - You MUST have your own, independent answers to the above three questions even if you worked together with others. All those who share the answers will get 0 credit if copied.
 - Due for the submission is Monday, Sept. 9!



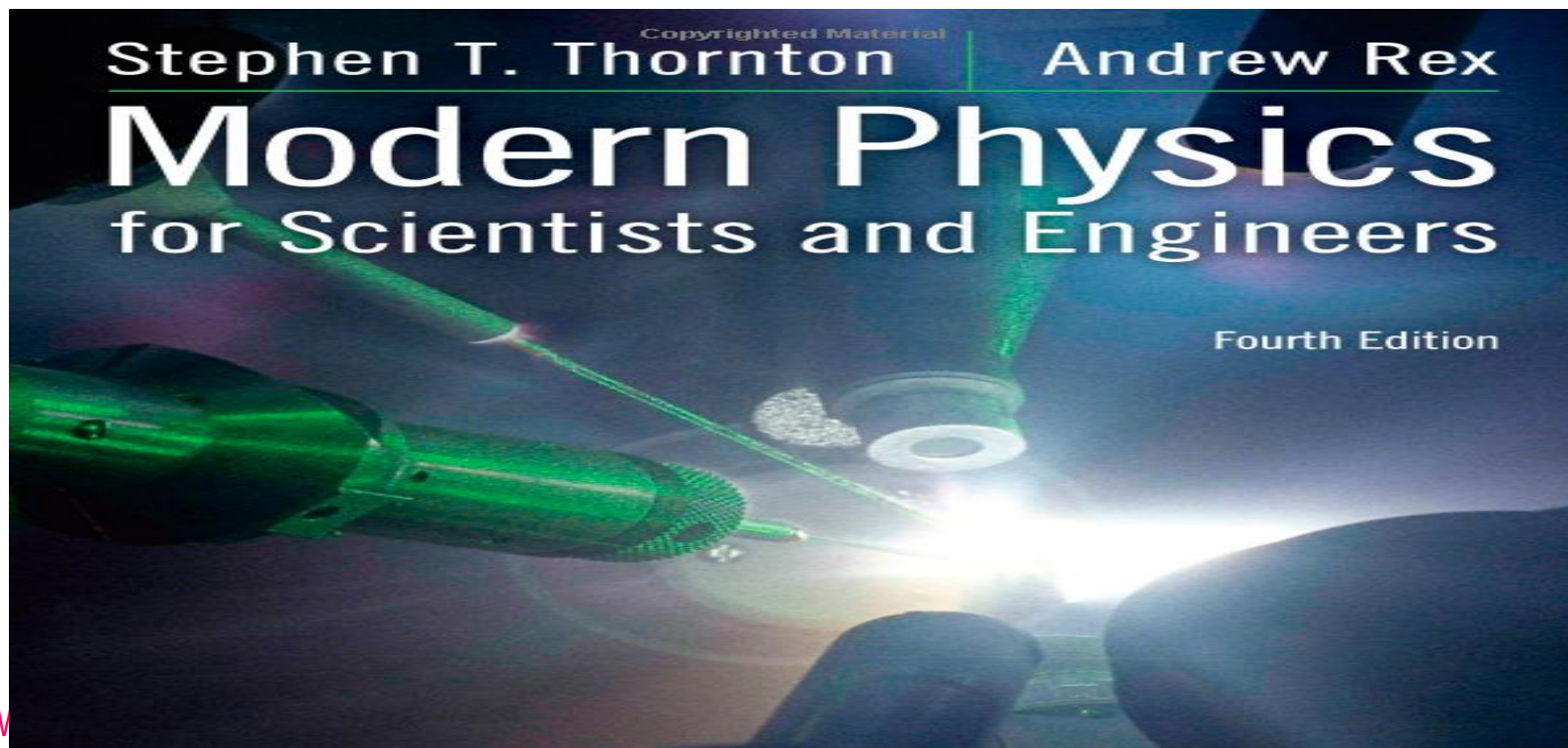
Information & Communication Source

- Course web page:
<http://www-hep.uta.edu/%7Eyu/teaching/fall13-3313-001/fall13-3313-001.html>
 - Contact information & Class Schedule
 - Syllabus
 - Homework
 - Holidays and Exam days
 - Evaluation Policy
 - Class Style & Communication
 - Other information
- Primary communication tool is e-mail: Make sure that your e-mail at the time of course registration is the one you most frequently read!!
- Office Hours: 2:30 – 3:40pm, Mondays and Wednesdays or by appointments



Textbook

- Title: Modern Physics for Scientists and Engineers
 - 4th edition
- Authors: S.T. Thornton and A. Rex
- ISBN: 978-1-133-10372-1



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2013



Dr. Jaehoon Yu

Evaluation Policy

- Homework: 30%
 - Exams
 - Mid-term Exam (Wed., Oct. 16): 20%
 - Final Comprehensive Exam (11 – 1:30pm, Mon, Dec. 9): 25%
 - Missing an exam is not permissible unless pre-approved
 - No makeup test
 - You will get an F if you miss any of the exams without a prior approval
 - Group Research Project: 15%
 - Pop-quizzes: 10%
-
- Extra credits: 10% of the total
 - Grading will be done on a sliding scale
 - 55% of the grade is in your hand!!

100%

Homework

- Solving homework problems is the only way to comprehend class material
- Consists of a lot of reading, deriving and writing
- Each homework carries the same weight
- **ALL** homework grades will be used for the final grade
- Home work will constitute **30% of the total**
 - A good way of keeping your grades high
- Strongly encouraged to collaborate
 - Just make sure to submit your own answers written in your OWN way!!

Attendances and Class Style

- Attendances:
 - Will be taken randomly
 - Will be used for extra credits
- Class style:
 - Lectures will be on electronic media
 - The lecture notes will be posted on the web **AFTER** each class
 - Will be mixed with traditional methods
 - Active participation through questions and discussions are **STRONGLY** encouraged → Extra credit....
 - Communication between you and me is extremely important
 - If you have problems, please do not hesitate talking to me



Class Communication Listserv

- An e-mail distribution list using the UTA Listserv system has been established:
 - PHYS3313-001-FALL13
- Please subscribe to the list as soon as possible:
 - Send e-mail to listserv@uta.edu from your most frequently read e-mail account to subscribe as follows
 - Without CC to any other e-mail, No subject or signature
 - Put in the body of the message
 - Subscribe PHYS3313-001-FALL13 FirstName LastName
 - The system will send you e-mail for you to confirm your own subscription → Please click the confirmation link
- Extra credit points
 - Done by midnight Friday, Aug. 30: 5 points
 - Done by midnight Sunday, Sept. 1: 3 points

Wednesday, Aug. 28,
2013



PHYS 3313-001, Fall 2013
Dr. Jaehoon Yu

Extra credit

- Up to 10% addition to the total
 - Could boost a B to A, C to B or D to C
- What constitute for extra credit?
 - Random attendances
 - Physics Colloquium Participations
 - Mark Nov. 6 colloquium by a National Academy of Sciences speaker → 3 times the normal credit!!
 - Strong participation in the class discussions
 - Special projects (these are the biggies!)
 - Watch the valid planetarium shows
 - Many other opportunities



Valid Planetarium Shows

- Regular running shows
 - Stars of the Pharaohs – Thursdays at 6:00, Saturdays at 5:30, Sundays at 1:30
 - Bad Astronomy – Fridays at 6:00, Saturdays at 2:30
- Shows that need special arrangements
 - Astronaut
 - **Black Holes (can watch up to 2 times!)**
 - Experience the Aurora
 - IBEX
 - Ice Worlds
 - Magnificent Sun
 - Mayan Prophecies
 - Nano Cam
 - Time Space
 - Two Small Pieces of Glass
 - Unseen Universe: The Vision of SOFIA
 - Violent Universe
 - We Are Astronomers
- How to submit for extra credit?
 - Obtain the ticket stub that is signed and dated by the planetarium star lecturer of the day
 - Collect the ticket stubs
 - Tape all of them on a sheet of paper with your name and ID written on it
 - Submit the sheet at the end of the semester when asked

What can you expect from this class?

- All A's would be perfect for you, wouldn't it?
 - But easy come easy go
 - Must put in efforts to make it last and meaningful....
- This class is going to be challenging!!
- You will earn your grade in this class.
 - You will need to put in sufficient time and sincere efforts
 - Exams and quizzes will be tough!!
 - Problems might not look exactly like what you learned in the class
 - Just putting the right answer in a free response problem will not cut!!
- But you have a great control of your grade in your hands, up to 55%!!!
 - Homework is 30% of the total grade!!
 - Means you will have many homework problems
 - Sometimes much more than any other classes
 - Sometimes homework problems will be something that you have yet to learn in class
 - Exam's problems will be easier than homework problems but the same principles!!
 - Group research projects!
 - Extra credit 10%
- I will work with you so that your efforts are properly rewarded

What do we want to learn in this class?

- The physics that provided fundamentals to the technical progress for us
- Learn concepts of quantum theory for microscopic phenomena and relativity for phenomena with high speed
- Learn physical principles that we still exploit
- Learn skills to express observations and measurements in mathematical language
- Learn skills to research literatures and express your research in systematic manner in writing
- Build up confidence in your physics abilities and to take on any challenges laid in front of you!!

Most importantly, let us have a lot of FUN!!



In this course, you will learn...

- Concepts and derivation of many of the modern physics
 - Special relativity
 - Quantum theory
 - Atomic physics
 - Condensed Matter physics
 - Nuclear physics
 - Particle Physics
- Focus on learning about the concepts with less complicated math
- You will be able to understand what fundamental physics provides bases for the current technology



Why do Physics?

Exp. { • To understand nature through experimental observations and measurements (**Research**)

Theory { • Establish limited number of fundamental laws, usually with mathematical expressions
• Predict the nature's course

⇒ Theory and Experiment work hand-in-hand

⇒ Theory works generally under restricted conditions

⇒ Discrepancies between experimental measurements and theory are good for improvements

⇒ Improves our everyday lives, even though some laws can take a while till we see them amongst us

Brief History of Physics

- AD 18th century:
 - Newton's Classical Mechanics: A theory of mechanics based on observations and measurements, concepts of many kinematic parameters, including forces
 - First unification of forces – planetary forces and forces on the Earth
- AD 19th Century:
 - Electricity, Magnetism, and Thermodynamics
- Late AD 19th and early 20th century (Modern Physics Era, after 1895)
 - Physicists thought everything was done and nothing new could be discovered



State of Minds in late 19th Century

- **Albert A. Michelson, 1894**

The more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote. Our future discoveries must be looked for in the sixth place of decimals!

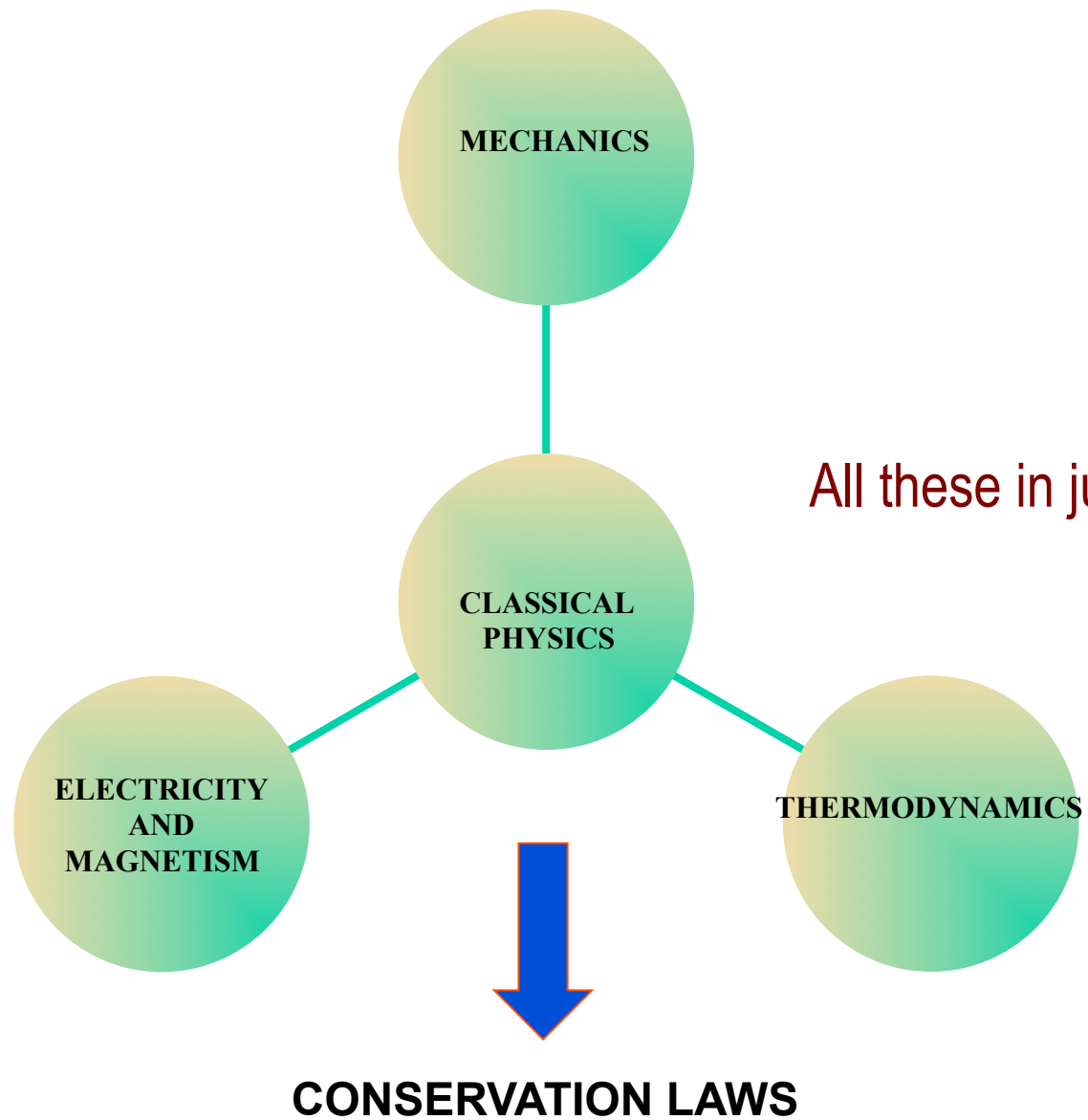
- **William Thompson (Lord Kelvin), 1900**

There is nothing new to be discovered in physics now. All that remains is more and more precise measurement.

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 - Physicists thought everything was done and nothing new could be discovered
 - Concept of atoms did not quite exist
 - There were only handful of problems not well understood late 19th century became the basis for new discoveries in 20th century
 - That culminates in understanding of phenomena in microscopic scale and extremely high speed approaching the speed of light
 - Einstein's theory of relativity: Generalized theory of space, time, and energy (mechanics)
 - Quantum Mechanics: Theory of atomic phenomena





All these in just 200 years!!

Triumph of Classical Physics: The Conservation Laws

- **Conservation of energy:** The total sum of energy (in all its forms) is conserved in all interactions.
- **Conservation of linear momentum:** In the absence of external forces, linear momentum is conserved in all interactions.
- **Conservation of angular momentum:** In the absence of external torque, angular momentum is conserved in all interactions.
- **Conservation of charge:** Electric charge is conserved in all interactions.



Mechanics

- Galileo (1564-1642)
 - First great experimentalist
 - Principle of inertia
 - Established experimental foundations



Isaac Newton (1642-1727)

Three laws describing the relationship between mass and acceleration, concept of forces → First unification of forces!!

- **Newton's first law** (*law of inertia*): An object in motion with a constant velocity will continue in motion unless acted upon by some net external force.
- **Newton's second law**: Introduces force (F) as responsible for the the change in linear momentum ($\mathbf{p}$):
 - $\vec{F} = m\vec{a}$ or $\vec{F} = \frac{d\vec{p}}{dt}$
- **Newton's third law** (*law of action and reaction*): The force exerted by body 1 on body 2 is equal in magnitude and opposite in direction to the force that body 2 exerts on body 1.

$$\vec{F}_{21} = -\vec{F}_{12}$$



Electromagnetism

- Contributions made by:
 - Coulomb (1736-1806)
 - Oersted (1777-1851)
 - Young (1773-1829)
 - Ampère (1775-1836)
 - Faraday (1791-1867)
 - Henry (1797-1878)
 - Maxwell (1831-1879)
 - Hertz (1857-1894)



Culminates in Maxwell's Equations

- In the absence of dielectric or magnetic materials, the four equations developed by Maxwell are:

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

Gauss' Law for electricity

A generalized form of Coulomb's law relating electric field to its sources, the electric charge

$$\oint \vec{B} \cdot d\vec{A} = 0$$

Gauss' Law for magnetism

A magnetic equivalent of Coulomb's law relating magnetic field to its sources. This says there are no magnetic monopoles.

$$\oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt}$$

Faraday's Law

An electric field is produced by a changing magnetic field

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{encl} + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$$

Generalized Ampère's Law

A magnetic field is produced by an electric current or by a changing electric field

Thermodynamics

- Deals with temperature, heat, work, and the internal energy of systems
- Contributions made by:
 - Benjamin Thompson (1753-1814)
 - Sadi Carnot (1796-1832)
 - James Joule (1818-1889)
 - Rudolf Clausius (1822-1888)
 - William Thompson (1824-1907)



Primary Results of Thermodynamics

- Introduced thermal equilibrium
- The first law establishes heat as energy
- Introduces the concept of internal energy
- Interprets temperature as a measure of the internal energy
- Generates limitations of the energy processes that cannot take place

