Physics 121: Optics, Electricity & Magnetism

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SFU Physics

Spring 2010

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Acknowledgements

- Lecture Slides: Dugan O'Neil, Spring 2009
- Demonstrations: Jeff Rudd

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- Phys 131 is the lab course. Should be taken in conjunction with Phys 121. We will try to correlate the two, but complete correspondence isn’t possible.

Physics 121: Optics, Electricity & Magnetism

Time/Rm:	MWF: 9:30 Rm: B9201
Tutorials:	Tues or Thurs – start next week.
Instructor:	Neil Alberding
Textbook:	"Physics for Scientists and Engineers, Second Edition" Randall D. Knight
Office Hrs:	P9444 MW 11:00-12:00
Final Exam:	Wed. April 21, 12:00–15:00

Technical Details

Grading

- Weekly Assign. = 15 %
- Midterm = 2x15% = 30%
- Tutorial Attendance = 5%
- Final = 50 %

Resources

- Notes: http://webct.sfu.ca/
- Mastering Physics: http://www.masteringphysics.com
- Each other, TAs, me
- Other 1st-year texts: Tipler, Halliday-Resnick-Krane, other University Physics textbook.

Course Web Site: http://webct.sfu.ca

- login using your SFU computing id and password
- Course materials including lecture notes, assignments, etc. all posted there
- Check your grades
- Can use the chat room to discuss with other students and send messages to other students (Warning: Instructors and TAs can see.)

Mastering Physics: http://www.masteringphysics.com

- We will use “mastering physics” for some assignment questions.
- You need the student access code which comes with your textbook (or you can buy one at the bookstore)
- You must register for the course: SFUPHYSICS121A
- You need your student ID and SFU postal code ”V5A 1S6”

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- There is no 100% final exam option in this course.

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Jane fully understands half of that material and so gets 4/8. Dick gets 0/8. Jane comes out ahead (3.25%).

Standard Calculators

As you know, for midterms and exams you need to use a simple scientific calculator - Aurex SC6145 (or SC6108), available at the bookstore.

Course Content

The Title of the course says it all: Optics, Electricity and Magnetism. In very broad strokes:

- Waves
- Optics
- Applied Optics (eg. lenses, gratings)
- Electricity (Coulumb's Law, Gauss' Law)
- Applied Electricity (eg. circuits)
- Magnetism
- Applied Magnetism (eg. cyclotrons)

Of course, there will be many other things learned along the way, but that is the gist...

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Particles and Waves

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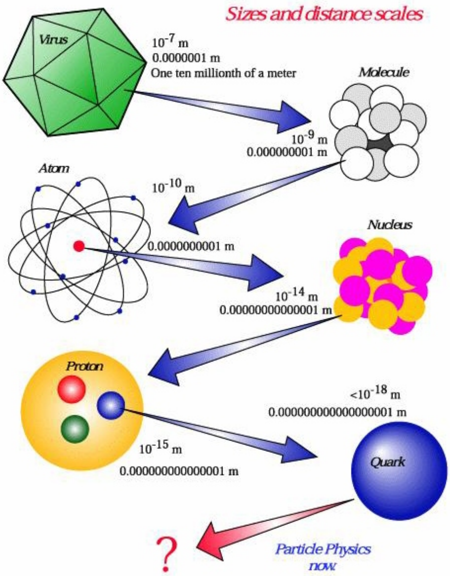
So far (in Physics 120) you have been learning to model nature based on particles. You know how to treat projectiles, billiard balls, etc. You have even taken those particles and allowed them to oscillate (SHM). This is one very useful way to look at things!

Particle Physics

At the smallest distance scales, what is the world made of? How do those components interact?

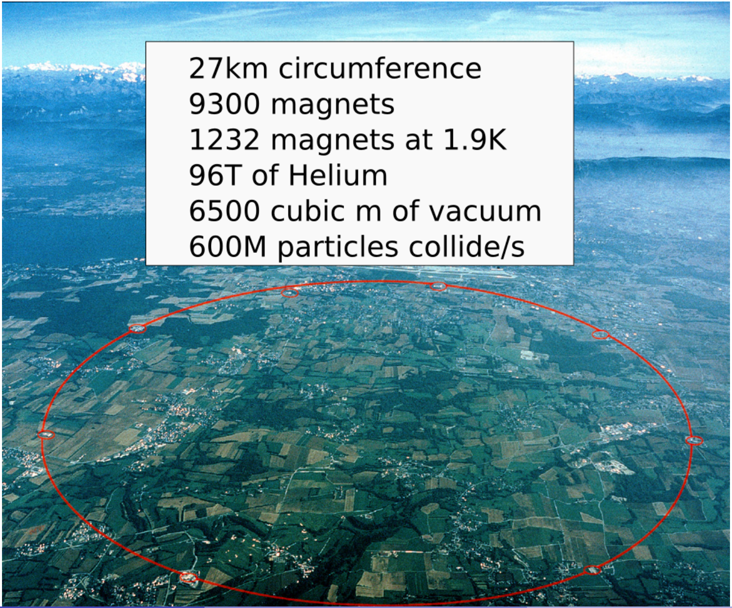
By convention there is color,
By convention sweetness,
By convention bitterness,
But in reality there are atoms and space.
-Democritus (c. 400 BCE)

Particle Physics



- On the way down in scale we have discovered hundreds of particles
- However, the fundamental ones are few...

Big Machines to see Small Things (when they work!)



Why we need big machines to see small things

SLIDE STOLEN FROM P485 - INTRODUCTION TO ELEMENTARY PARTICLES

We use particles as probes, remember what we learned from de Broglie

$$\lambda\!\!\!^{-} = \frac{\lambda}{2\pi} = \frac{\hbar}{p}$$

Example	Energy	Wavelength
visible light	0.4 eV	5×10^{-7}m
electron microsope	90 keV	4×10^{-12}m
X-rays (crystallography)	10-50 keV	10^{-10}m
protons	100 MeV	3×10^{-15}m
photon	200 MeV	10^{-15}m
Hera (e-p collider)	314 GeV	10^{-19}m

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If you go on to second-year physics (eg. P285) you will see enough Quantum Mechanics to hear about “wave-particle duality”. It is even in Chapter 25 of your textbook...I hope we get to discuss it in a couple of weeks.

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What is Light?

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- First Greek scientists do not distinguish between light and vision.
- At some point we realize that light is a physical entity in its own right. It actually moves!!

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- 2010: Students in Physics 121 are fascinated and confused by light.

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2. Call on the telephone ("like a wave")

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- The object in this course is not to understand what light *is* but to describe what light *does*.

The Speed of Light - Yes it moves

The speed of light in a vacuum is

$$c = 3.00 \times 10^8 \text{ m/s } (2.99792458 \times 10^8 \text{ m/s } \textit{exactly})$$

- Einstein tells us that nothing can travel faster than c.
- c is such a mind-boggling speed that it is difficult to perceive that light moves at all.
- Many brilliant experimentalists tried to measure the speed of light over the centuries.

Galileo uncovering lamps on distant mountaintops

"If not instantaneous, it is extraordinarily rapid"

but Fizeau managed it in 1849.

Douglas Adams

Nothing travels faster than the speed of light with the possible exception of bad news, which obeys its own special laws.

The Speed of Light

- The speed of light is not always c. Outside a vacuum light travels at a speed less than c
$$v = \frac{c}{n}$$
where n is the "index of refraction" and is always at least 1.

- Some examples

medium	n
vacuum	1 (exact)
air (at $0^\circ C$)	1.00029
water (at $20^\circ C$)	1.33
glass	$\sim$1.5