Big Bang, Black Holes, No Math

ASTR/PHYS 109

Dr. David Toback

Lectures 7 & 8
Prep For Today (is now due) - L8

No one in back 4 rows and no laptops or cellphones

• iClicker:
  - Make sure to register by clicking on the link in eCampus (will be in the Home area)

• Reading:
  - (BBBHNM Unit 2/Chapters 5-9)
  - Recommended Reading:
    • See P3 of http://people.physics.tamu.edu/toback/109/Syllabus.pdf

• Warmup Quizzes:
  - Warm-up Quiz Part 4 (Peerceptiv): Will assign soon

• Pre-Lecture Reading Questions:
  - Unit 2 Text Submission: Date pushed to be due before class today
    • Submit your 4 questions to TurnItIn in eCampus (under Turnitin Assignments).
    • Only submission was required today
    • Submit ONLY 4, need all 4 to be excellent to pass
    • Not all grades posted yet
    • Pass/Revise assignment. If you don’t pass we will set up dates for Revisions after you get Feedback
  - Unit 2 Quiz: Will open up for you in eCampus AFTER they are graded and you get a Pass. Also requires Unit 1 and EOC 3. Final due date not yet assigned

• End-of-Chapter Quizzes
  - EOC 4: Was due before class today

Big Bang, Black Holes, No Math

Physics We Need

Topic 1: Light and Doppler Shifts
The Topics

• Some stuff we need learn a little about:
  1. Light and Doppler Shifts
  2. Gravity, General Relativity and Dark Matter
  3. Atomic Physics and Quantum Mechanics
  4. Nuclear Physics and Chemistry
  5. Temperature and Thermal Equilibrium

• We won’t spend too long on each, just enough to get back to the big picture...

• Since there is no perfect way to present them (they all tie into each other) we’ll just start somewhere and get going...
Light

What we know about the universe comes from multiple places.

One of the most important is from looking at both outer space and “inner” space.

Need to know more about the “light we see.”
Outline for Light

1. Light is a wave...
2. ...and a particle
3. Light is REALLY fast, but does have a finite speed
4. Doppler effect
Part 1: Light is a Wave

• The light we see is a “wave”, like waves on an ocean

• Best described by it’s wavelength
Why do we believe light is a wave?

- Water and Sound are also both waves
  - Does light behave like water or sound?
- Can “see” water waves hitting a wall and what happens to them when they hit two small openings in a wall
Water waves moving towards a wall

You are in the sky looking down at the waves as they go by
(Would see the same thing if you drop a rock in some water)
Why do we believe light is a wave?

Shine light from a laser at two small holes in a wall and see what comes out on the wall behind it. The waves make patterns on the wall the same way water waves do.

Can measure the wavelength

(Physics 202 & 208)
The Wavelength of Light

- Have also observed that when we shine white light at a prism and it breaks up into its different colors.
- Each color has a different wavelength which we can also measure.
Light is more than the colors we see.

You may have thought of **Radio Waves and X-rays** as different things, but they are just **light** with different wavelengths.
Part 2: Light is a particle

- What if we look at smaller and smaller “amounts” of light?
- The light we see is actually LOTS of particles all moving together
- Call these **Photons**

Lots of photons where it's bright

Very few photons where it's dark
White Light = Lots of Different Color Photons
Physics We Need

Topic 1: Light and Doppler Shifts

Another view...

Waves move this way

Big waves where the peaks overlap

Small waves where a peak meets a trough

Lots of photons where it is bright

Very few photons where it is dark
The Energy of Particles

We can think about Energy in many ways

- One way is the “energy of motion”
  - Kinetic Energy in the language of PHYS 201 and 218

- For a particle (with mass) in motion:
  - The higher the speed the particle has, the more energy it has
  - The more mass the particle has (the heavier it is) the more energy it has
Clicker Question for Energy

Which has more energy? (Which will do more damage to a tree?)

1. A) A Prius moving at 10mi/hr or B) An SUV at 10mi/hr?
2. A) An SUV moving at 10mi/hr or B) An SUV moving at 60mi/hr?
3. A) A Prius moving at 60mi/hr or B) An SUV moving at 10mi/hr? C) Depends on the masses of the Prius and the SUV
What do we know about photons?

- Photons are a type of fundamental particle
  - Like an electron or a quark
- Higher energy → smaller wavelength
- Has no mass, but does have energy
  - Aside for those of you who are interested: It has momentum
A Particle and a Wave

- Actually it’s really more complicated than that
- Light is both a wave and a particle... can describe it as either... it has properties of both
Prep For Next Time – L8

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- End-of-Chapter Quizzes
  - If we finished Chapter 5 then End-of-Chapter Quizzes 5a & b (else just Chapter 4) before the next class