Was due Today - L15

- Reading:
  - (BBBHNW Unit 2)
- Pre-Lecture Reading Questions Quiz:
  - (Unit 2 Text Submission and Unit 2 Quiz)
- End-of-Chapter Quizzes:
  - (Chapter 7, quizzes 7a and 7b)
- Papers (All items due at 11:55PM in Peerceptiv)
  - Paper 1:
    - Grades posted
    - Want a re-grade? Instructions online
  - Paper 2:
    - Draft for Feedback (Optional)
      - Due on eCampus/TurnItIn before Friday Oct 18th
      - Will do our best for late submissions
    - Text: Due Wednesday Oct 23rd (Grace period with late penalties)
      - Submit to Peerceptiv AND TurnItIn
    - Reviews: Open Saturday Oct 26th, Due Monday Oct 28th (Grace period with late penalties)
    - Back Evaluations: Open Thursday Oct 31st, Closes Monday Nov 4th

Big Bang, Black Holes, No Math  Topic 4: Nuclear Physics & Chemistry
Heads Up: Paper 2

- What is the evidence that Stars are made of Atoms?
- This will be the topic of Paper 2

- In order to understand the evidence, we next talk about Atoms and how they work
- Will be assigned after we finish Chapter 8
Outline for Unit 2: Physics We Need

1. Light and Doppler Shifts ← Done
2. Gravity, General Relativity and Dark Matter ← Done
3. Atomic Physics and Quantum Mechanics ← Done
4. Nuclear Physics and Chemistry ← This time
5. Temperature and Thermal Equilibrium

Big Bang, Black Holes, No Math

Topic 4: Nuclear Physics & Chemistry
Different energy levels for each different type of atom

Fingerprinting the different atoms

Hydrogen Helium Boron

Can use light of different energies to identify atoms: Different Colors
Unique Fingerprints

- Look at light from a light bulb with Hydrogen gas in the way
- Different lines will be absorbed by Helium
- Can now identify a mystery gas!

From the spectrum, we can tell that our mystery gas is Hydrogen.
What would happen inside a giant ball of hydrogen?
- Atoms would fall to the center (due to gravity) and bash into each other.

What would that look like to us?
- Light from their interactions.
- Next look at interactions.
Stars Shining

- Nuclear interactions in the center of the star create lots of energy which is eventually emitted as light from the surface of the star.
  - Shines white (or yellow)
What else can we learn from the light?

- This light passes through other atoms of the star
  - Light is “absorbed” by the outer atoms → Spectral lines

- Tells us what the stars are made of
Looking at the Stars

From the spectrum, we can tell the star is made of Hydrogen gas.
Analyzing Absorption Spectra

- Each element produces a specific set of absorption (and emission) lines
- Using this information, we can study the composition of stars

See only spectral lines for known atoms
Remarkable...

- The Sun and stars are mostly made of Helium and Hydrogen
- Our Sun is made of the same stuff as all the other stars!
- The stuff out in the universe is made of the same stuff that is found here on Earth!
Even More Remarkable

If all the stuff “out there” looks the same as the stuff here on Earth then:

- The particles out there (electrons, protons, photons etc.) are the same as they are here

- The laws of physics that govern putting together protons, nuclei and atoms are likely to be the same everywhere!

- Provides evidence that it’s been this way for billions of years!
Now that we know what stars are made of and what they are SUPPOSED to look like, can we learn anything else?
• What if the stars were MOVING?

• Can we tell? Yes!

  Doppler effect

  How?
Atoms with Different Speeds

• If an atom emits a photon it will correspond to an energy that reflects the change of two energy levels

• However if the atom is MOVING the light will be shifted to a different color
Observing an Atom

Atom Emitting Light

Can use this to study the motions of the stars
Looking at the Stars

From the spectrum, we can tell the star is made of Hydrogen gas. This provides additional evidence that stars are made of atoms. From the spectrum, we can tell the star is made of Hydrogen gas, and moving away from us.
Lecture on Chapter 8 now complete
Abbreviated description: What is the evidence that Stars are made of Atoms?

More detail on Peerceptiv, you REALLY need to read ALL the instructions

Explain it to someone who isn’t taking the class (no jargon)

Format:

Introduction paragraph
- Lawyers opening arguments at a Trial
- ~1 paragraph per piece of evidence/talking point
  - The case at a Trial

Conclusion paragraph that ties it together
- Lawyers closing arguments at a Trial

http://people.physics.tamu.edu/toback/109/WritingAssignments/samplepaper.shtml
Where we are...

Topics
1. Light and Doppler Shifts ← Done
2. Gravity, General Relativity and Dark Matter ← Done
3. Atomic Physics and Quantum Mechanics ← Done
4. Nuclear Physics and Chemistry ← Done
5. Temperature and Thermal Equilibrium ← This Time
Looking at the Lights in the Sky

What we know about the universe comes from multiple places

So far:
  • Learned about the light coming from the Sun and the other stars
  • The evidence that stars are made of atoms
Other Stuff Out There...

• We don’t just look at the stars...
• We can learn a lot from looking at light in other ways too...
  - Talk about this today...
The World in a Jar

As we'll see, in many ways when we look at the stuff in the sky (other than the stars) it looks like we're sitting in a giant jar of stuff, like atoms.

**What does it look like to sit inside a jar of atoms or photons?**

**Why should you care?**
Start Simple: Atoms in a Jar

• Since we can see how atoms interact in a jar on Earth, we can predict what would happen on Universe sizes

• Next: learn what it’s like to be inside a jar filled with atoms

• Gas (bunch of atoms) is well described by its Temperature and will eventually come into Thermal Equilibrium

  - Describe both these ideas next
 Prep for Next Time – L15

- Reading:
  - BBBHNM Unit 3: Due Monday before class
- Pre-Lecture Reading Questions Quiz:
  - Unit 3 Quiz: Due Wednesday before class
- End-of-Chapter Quizzes:
  - If we finished Chapter 9 then end-of-chapter quiz 9 (else just quizzes 8a and 8b)
- Papers (All items due at 11:55PM in Peerceptiv)
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