Was Due for Today - L19

- Reading:
  - (Unit 2)

- Pre-Lecture Reading Questions Quiz:
  - (Unit 2 Text Submission and Unit 2 Quiz)

- End-of-Chapter Quizzes
  - (Chapter 6)

- Papers
  - The text of Paper 1 was due in Peerceptive and TurnItIn (in eCampus) on Friday Feb 21st
  - Reviews and back-evaluations become available as your fellow Aggies move through the system.
  - You are required to finish each Review within 72 hours after being assigned it. You are required to finish each Back-evaluation within 72 hours of a Reviewer finishing and it being assigned you. Not doing them on time will cause you to get a zero, and you'll have to start over.
  - You need to pass the Review and Back-Evaluation stage to get a grade
  - You can submit a revision at any time, but you have to do a new set of Reviews and Back-evaluations for it to count
If a photon with the right energy hits an atom and is absorbed, the electron can "jump" to an "excited state"
If an atom is in an excited state, it’s just a matter of time before it emits a photon with exactly the energy between the two states.
Photons and Atoms

Photons can interact with Atoms in three ways

1. Very low energy photon: Because the electron in the atoms can only have quantized states around the nucleus, VERY low energy photons will be ignored, or bump the atom.
   - Ignoring is a kind of interaction

2. If an atom encounters a photon with the “right energy” photon it can get “excited” and go into a higher energy state. The photon is absorbed and is gone forever.

3. If a REALLY energetic photon comes along it can completely knock an electron out of orbit from a nucleus.
Putting it All Together

A cartoon of an atom and a photon

Note: The electron being completely out of the atom is a perfectly good “energy state”
Atomic Transitions

• Any photon that hits the atom with the right energy will be absorbed
• Absorbs only special colors
How is this helpful?

- Can look at light from a light bulb → all colors observed
- Look at light from a light bulb with Hydrogen gas in the way
  - Only special colors will be absorbed!

Atomic Fingerprinting
Atomic Fingerprints

• Each atom produces a large number of different wavelengths with VERY SPECIFIC values
• Quantum Mechanics predicts ALL of them
• If you see all the ones you expect and none you don't, that gives you confidence
Lecture on Chapter 7 now complete
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  ↵ Next
5. Temperature and Thermal Equilibrium
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
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 sky
• Learned that atoms can produce and absorb light
Questions We're Trying to Answer

- What are stars made of?
- What can we learn from looking at them?
- How do we know? What is the evidence?

Today: More about different types of atoms and the interactions that produce the light

→ A “smoking gun” piece of evidence that the light from the sky is from atoms out there
Outline

• Overview
• What protons and neutrons are made of: Quarks
• How protons and neutrons interact & combine to form a nucleus
• Spectral lines
  - Light from stars!
• Learning about the stars
Overview of the story

• Big things are made from LOTS of small things
• Small things: The Fundamental Building Blocks of Nature
  - What is the “stuff” in atoms
• ElectroMagnetism (electric charge)
  - What holds electrons and protons together
• Quantum Mechanics
  - Why atoms form the way they do
  - Electron in orbits
  - Atoms absorbing and emitting photons (light)

• Different TYPES of Atoms
  - The Strong Force
  - Keeping protons and neutrons together (atomic nuclei)
  - Nuclear Physics and Chemistry
  - Different atoms → Different light...
• Studying the Stars using their light
  - Spectral lines of the atoms
  - Atomic “fingerprints”
  - The light we see from the stars
Smaller Building Blocks of Nature

- Atoms are made of a nucleus surrounded by electrons
  - Many types of nuclei
  - Only one kind of electron
- Nuclei are composed of neutrons and protons
  - Neutrons and protons are two different types of nucleons
- Nucleons are made of quarks
• We can put nucleons together in lots of different ways...
• Each different way corresponds to a different type of atom
• Periodic table just labels the number of protons in the atom

Knew about the periodic table in the 19th century
Understood it was just combinations of protons and neutrons in the 1920's
The Number of Neutrons Also Matters

- The number of protons determines name (and other things)
- Number of neutrons determines which isotope it is
- Helium (He), with 2 protons, 2 neutrons and 2 electrons

Different numbers of neutrons ↔ different isotopes

- Helium\(_2\), with 2 protons, 2 neutrons and 2 electrons
- Helium\(_3\)
- Helium\(_4\)
- Deuterium
- Hydrogen
- Proton
- Neutron

Big Bang, Black Holes, No Math

Physic Topic 4: Nuclear Physics & Chemistry
What's in a name?

Name some things that we'll use over and over

• Neutral atom = Equal number of electrons and protons
• Ionized atom = An atom that doesn't have an equal number of protons and electrons (charged)
• Completely ionized atom = An atom with no electrons = A nucleus
• Free Proton = Completely ionized hydrogen atom = A hydrogen nucleus
• Free quark = A quark not inside a composite particle
  - Inside a proton it is a bound quark
  - This occurs in the early universe only (or in high energy experiments)
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
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 ← Done
5. Temperature and Thermal Equilibrium ← Next time
Prep For Next Time - L19

Reading:
- (Unit 2)

Pre-Lecture Reading Questions Quiz:
- (Unit 2 Text Submission and Unit 2 Quiz)

End-of-Chapter Quizzes:
- If we finished Chapter 8 then End-of-Chapter Quiz parts 8a and 8b (else, just 7a and 7b)

Papers
- Paper 1:
  - The text of Paper 1 was due in Peercept and TurnItIn (in eCampus) on Friday Feb 21st
  - Reviews and back-evaluations become available as your fellow Aggies move through the system.
  - You are required to finish each Review within 72 hours after being assigned it. You are required to
    finish each Back-evaluation within 72 hours of a Reviewer finishing and it being assigned you. Not
    doing them on time will cause you to get a zero, and you'll have to start over.
  - You need to pass the Review and Back-Evaluation stage to get a grade
  - You can submit a revision at any time, but you have to do a new set of Reviews and Back-evaluations
    for it to count
  - Grades posted soon
  - Paper 1 Revision:
    - Send mail to 109help@physics.tamu.edu if you want to do a Revision. We need to get Peerceptiv to
      open it for you.
  
  - Paper 2:
    - Draft for Feedback (Optional)
      - Will set a due date on eCampus/TurnItIn soon
      - Will do our best for late submissions
    - Text: Will set due date soon
      - Submit to Peerceptiv AND TurnItIn
    - Reviews and Back-evaluations: Same as before