Astronomy C10: Week 2

(Peter) Xiangyuan Ma | Sections : 104/105/101

Forgot to mention last time….

Grade breakdowns

Attendance/Participation
(section engagement)

Quiz 1/2 will be held in section!
(also held in sections)

Category	Points
Attendance/Participation	3
Homework	23
Lab Exercises	15
Quiz 1	7
Quiz 2	7
Midterm 1	25
Midterm 2	25
Final Exam	75
Total	**180**

Important: Quiz 1 next week!

Administered during section next week

20 minutes, pen-and-paper, closed book

~3 short answer questions divided into 2-4 parts each

Includes material from the first 3 HWs, emphasizing what we have covered in section

Please submit any DSP letters as soon as possible!

General tips for studying

Practice quiz and solutions (from today)

Make sure you're familiar with all formulae on equation sheet

Quiz problems will be fairly similar to homework problems, so you could try repeating homework problems from scratch (especially ones you got wrong!)

Come to office hours / TALC for any help!

This weeks plan!

Fingerprints of Atoms [~5-10 mins]

Arc Lamp Demo/Quiz Review [~15 -25 mins]

Quiz Review Take up [10 mins]

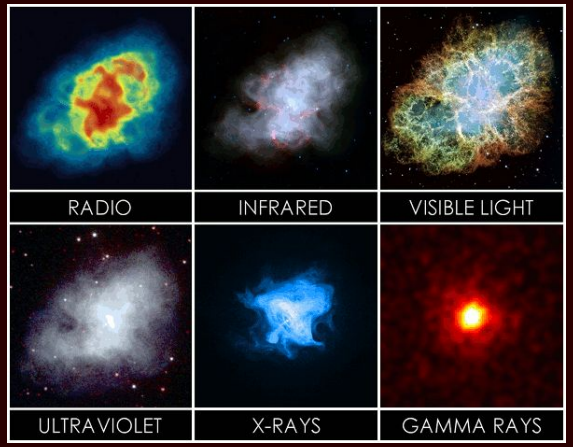
Doppler Effect + **Demo** [~5-10 mins]

Blackbody Radiation [~5 mins]

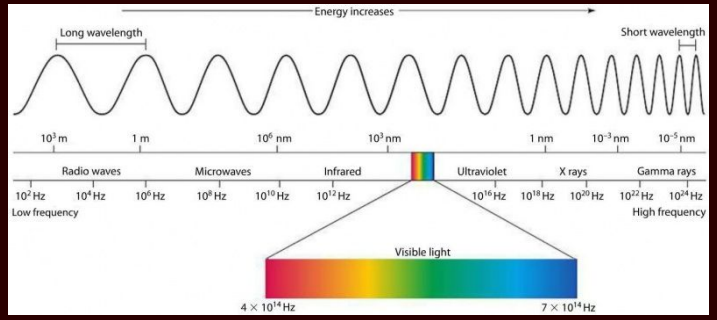
Questions? [Remaining time]

Last time….

Light is super important in astronomy



Light can behaves as a ***wave*** and particle



Fundamental equation for a wave

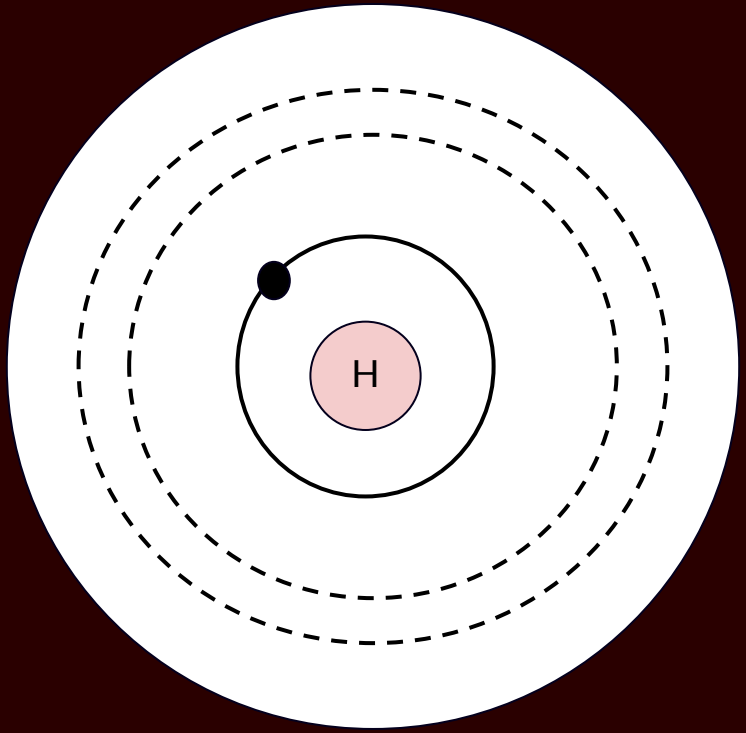
$$c = f\lambda$$

c = speed of light 3×10^8 m/s
λ = wavelength
f = frequency

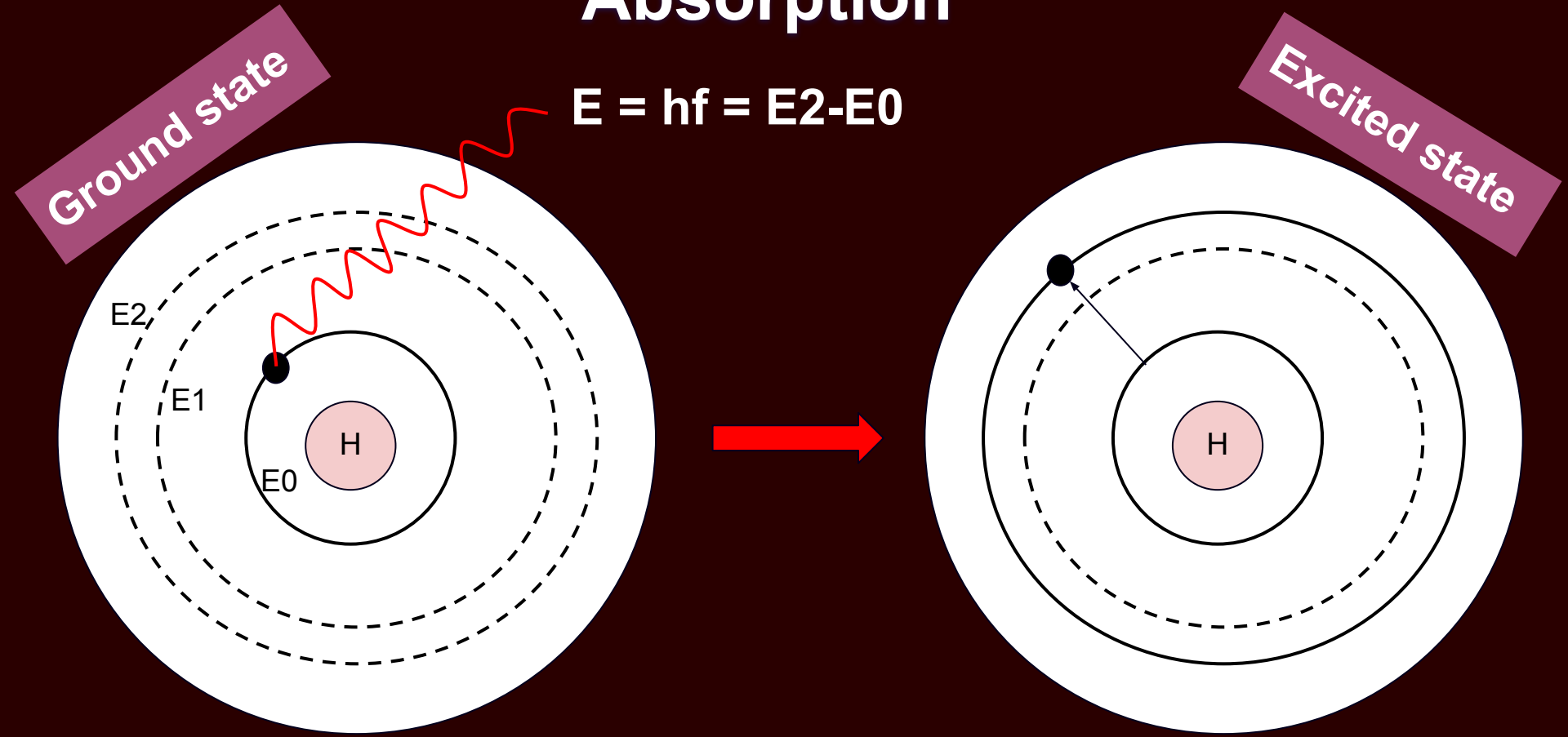
Wow

Fingerprints of Atoms [~10 mins]

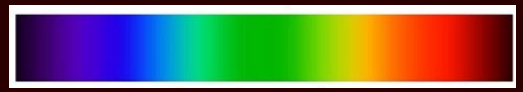
Absorption/Emission

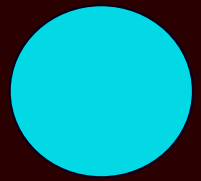


Absorption

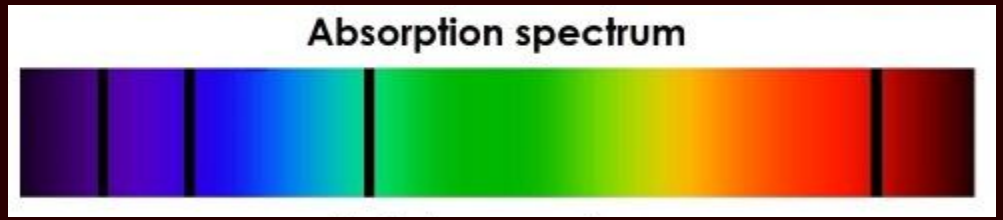


Absorption

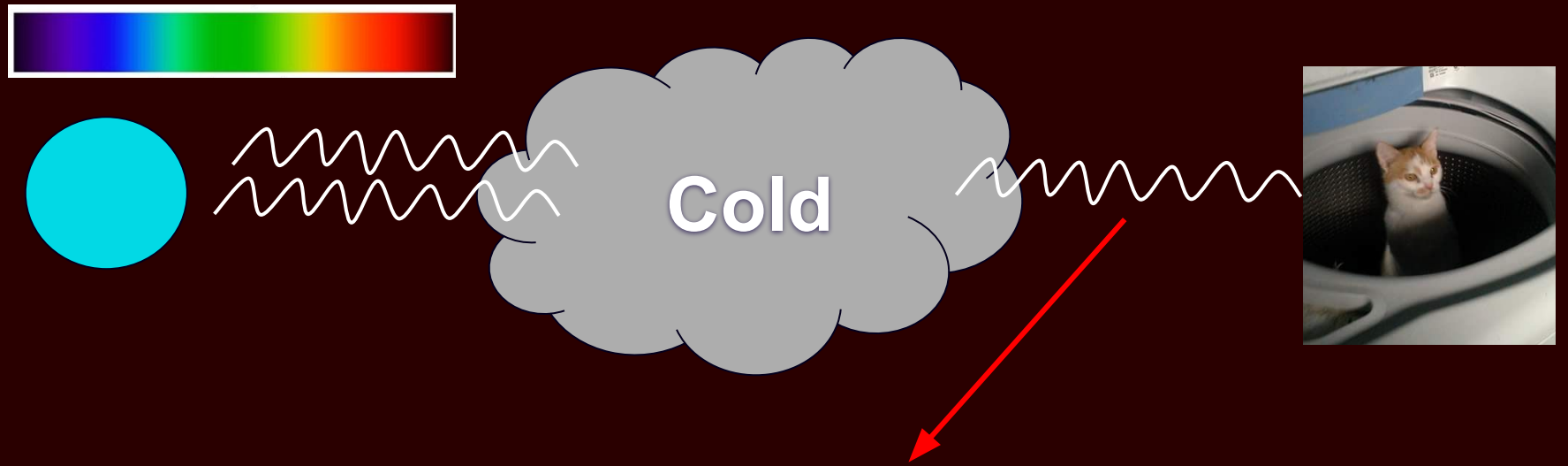




Cold

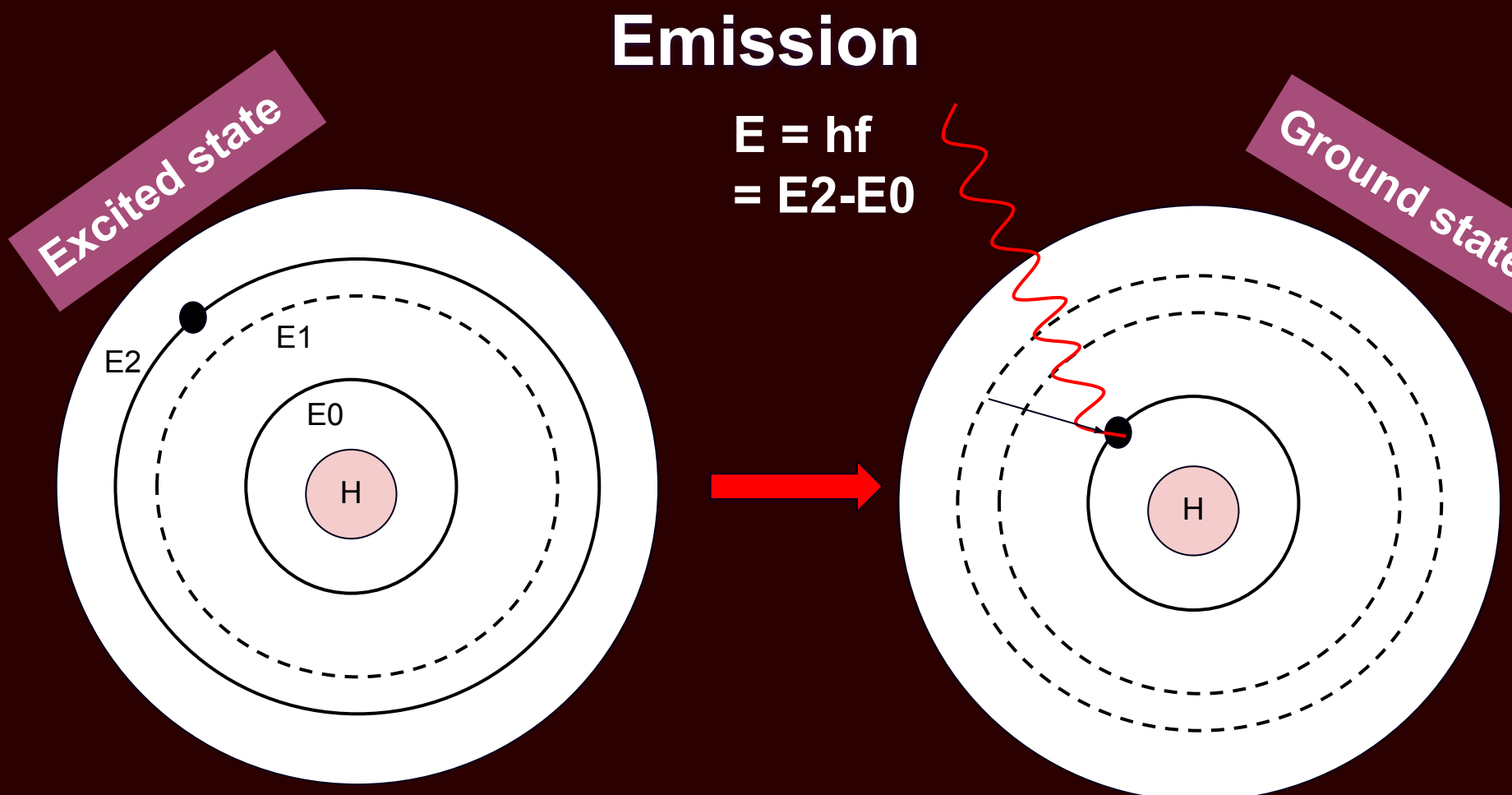


Absorption



Absorption spectra tell us what elements are present in **stars** and **planets**.

Emission

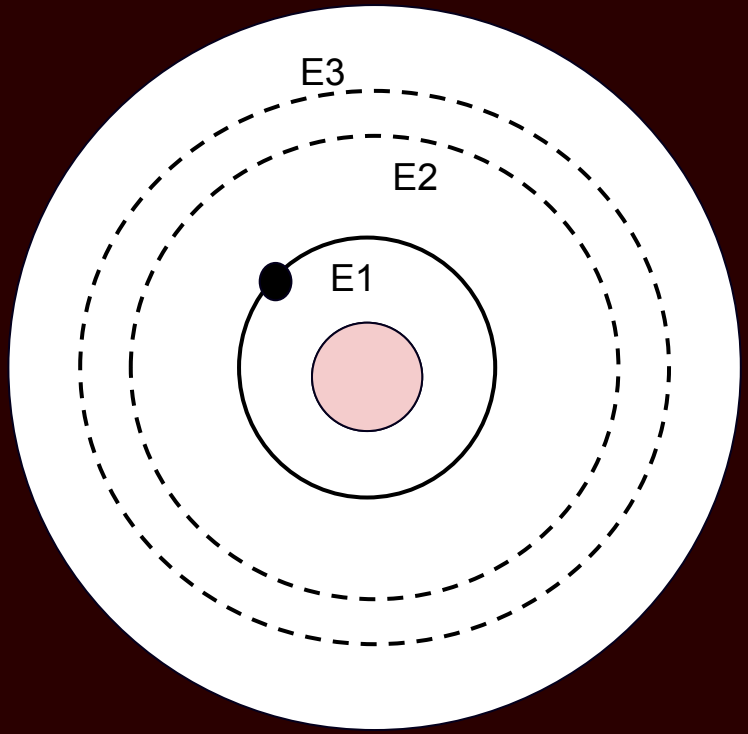


Emission

Emission

Emission spectra tell us about **gas clouds**, **nebulae**, and the physics of excited atoms

Each level corresponds to a different energy requirement



Level3
E=8

Level2
E=5

Level1
E=0

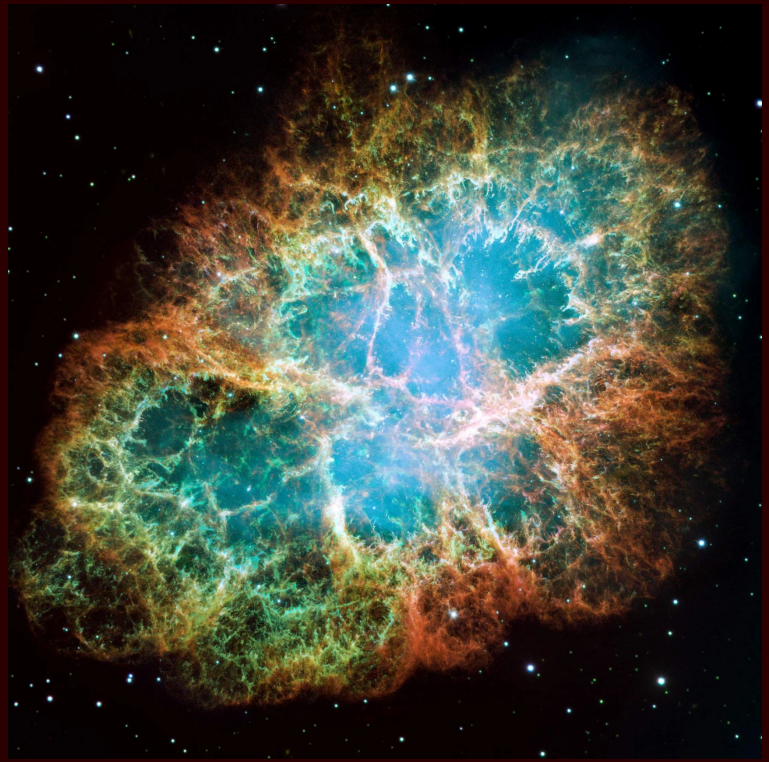
Each element has its own fingerprint!!

CARBON

OXYGEN

NITROGEN

IRON



Using only the light from our telescope, we can measure the chemical composition of objects thousands of light years away!

Incredible! Opens new ways to study the universe!

Why do we care?

Allows us to uncover the chemical make of the universe

Spectral absorption lines reveal what elements are present in a star's atmosphere.

This showed that stars are mostly hydrogen and helium, not Earth-like materials. And most materials are forged in supernovae or huge cataclysmic events.

"We are made of star stuff"

Summary

Electrons can occupy discrete energy levels

Absorption: electron absorbs photon to move to higher energy level

Emission: electron emits photon to move to lower energy level

Photon must have energy equal to the difference in energies between the initial and final energy levels!

Demo time! [~ 15 mins]

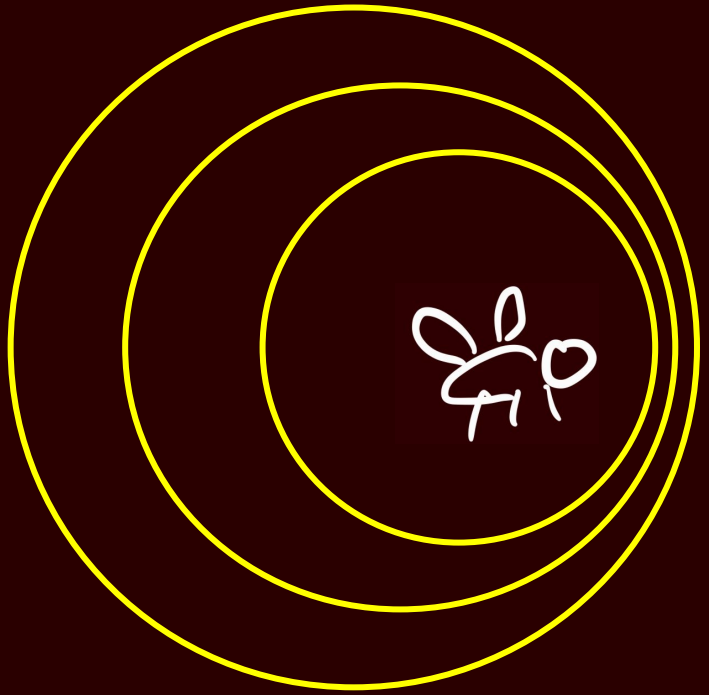
Quiz Review!
(bCourses)

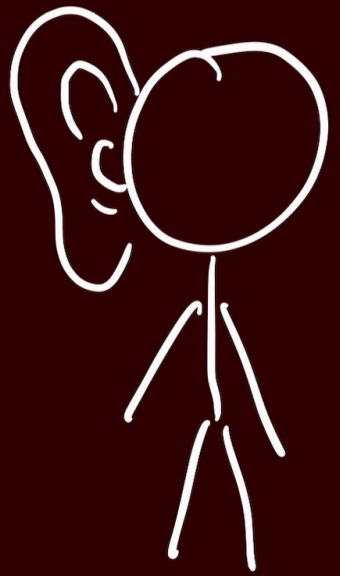
Discussion Section Resources>Peter Ma>Practice Quiz 1

Quiz review take up [10 mins]

Doppler Shift [~ 5 mins]

Doppler Effect





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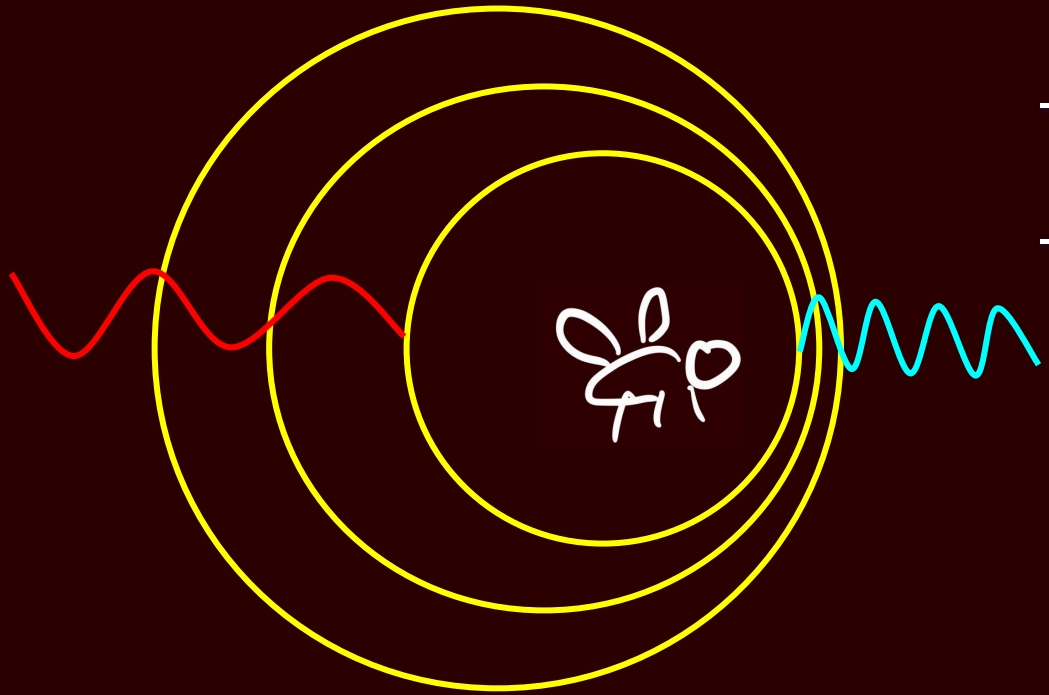

- Moving toward you: bluer
  - (shorter λ)
- Moving away from you: redder
  - (longer λ)

$$\frac{\Delta\lambda}{\lambda_{rest}} = \frac{\lambda_{obs} - \lambda_{rest}}{\lambda_{rest}} = \frac{v}{c}$$

Doppler Effect

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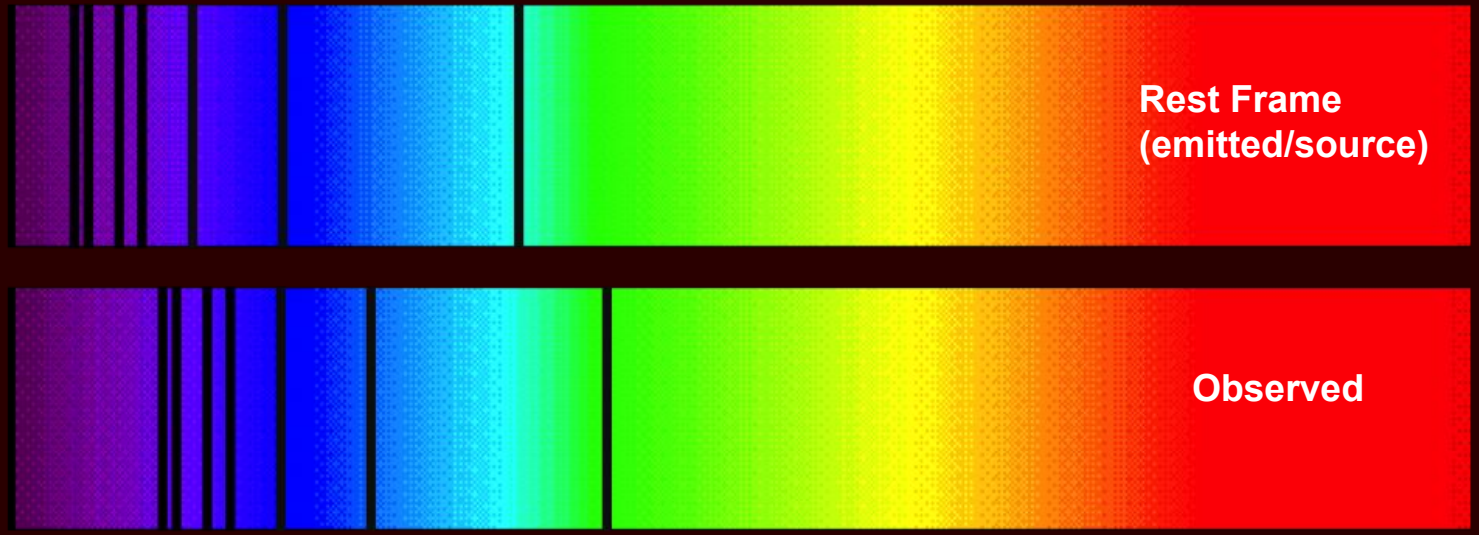


Why do we care?

It allows us to measure how fast things are moving.

We measured how fast distant galaxies are moving

And we found that all galaxies were moving away from us!

This means the universe is expanding

If the universe is always expanding outwards, at one point universe was one singularity => Big Bang?

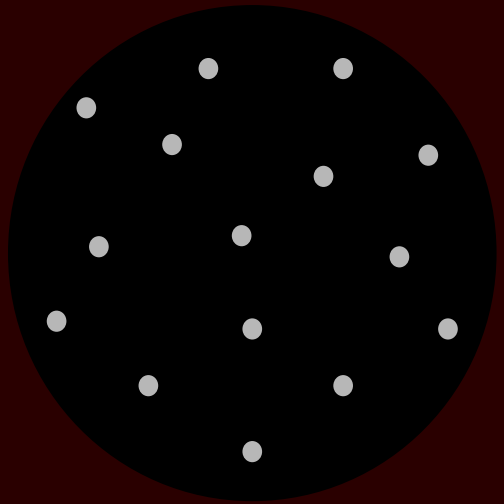
Demo [if time]

Blackbody Radiation [5-10mins]

Thermal Radiation

Blackbody: perfect thermal emitter

1) All radiation falling upon blackbody is absorbed (none transmitted or reflected)



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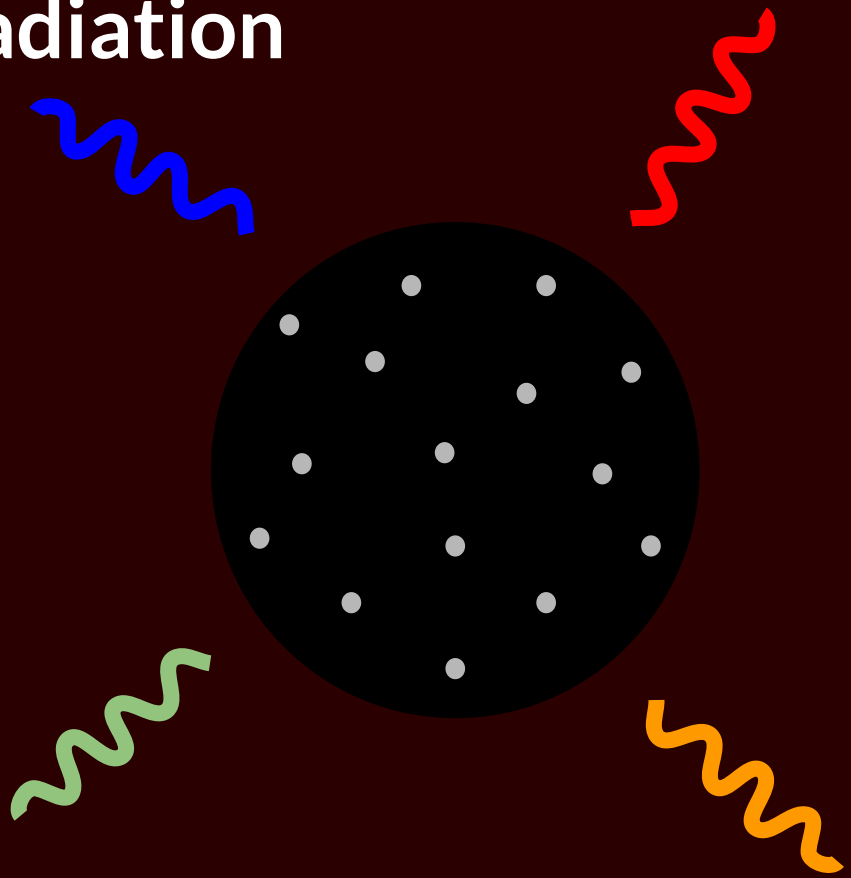

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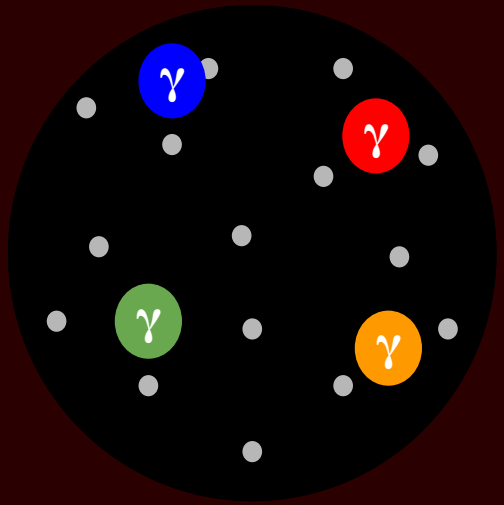

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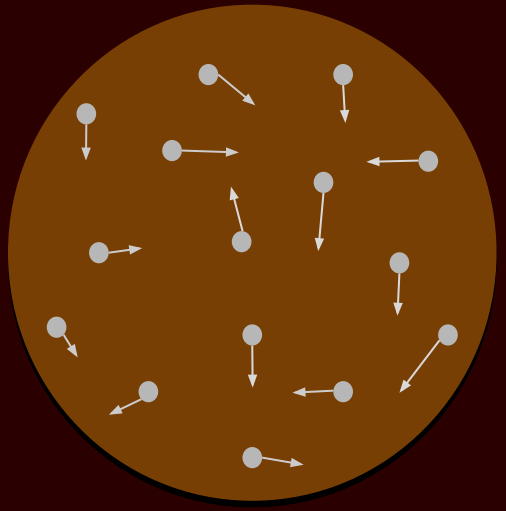

Thermal Radiation

Blackbody: perfect thermal emitter

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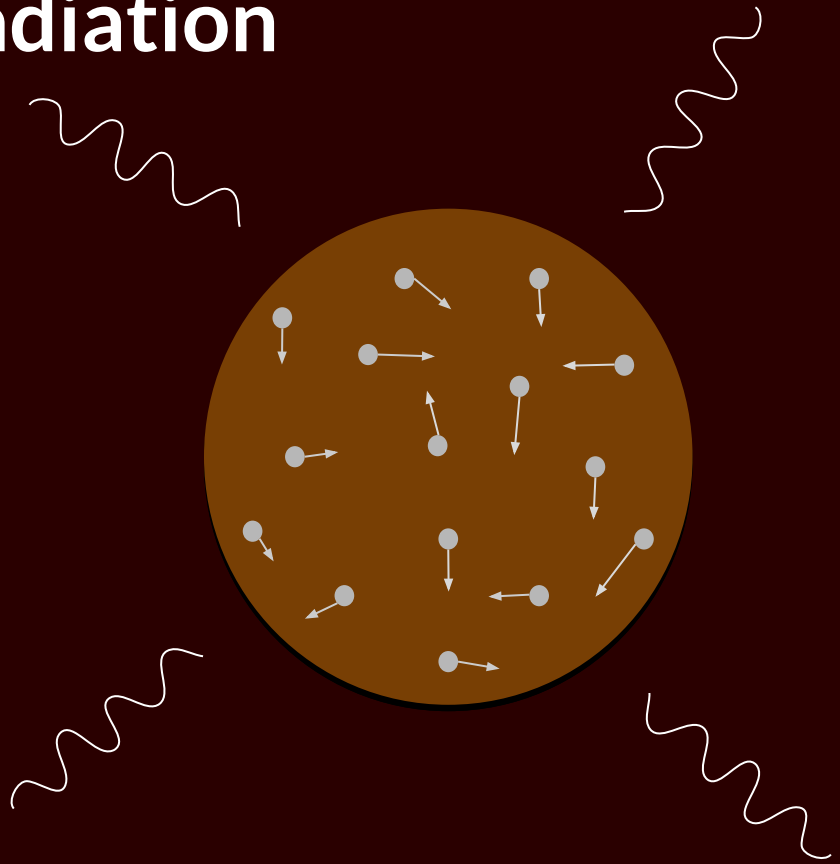
3) Accelerating charged particles within the blackbody then emit light



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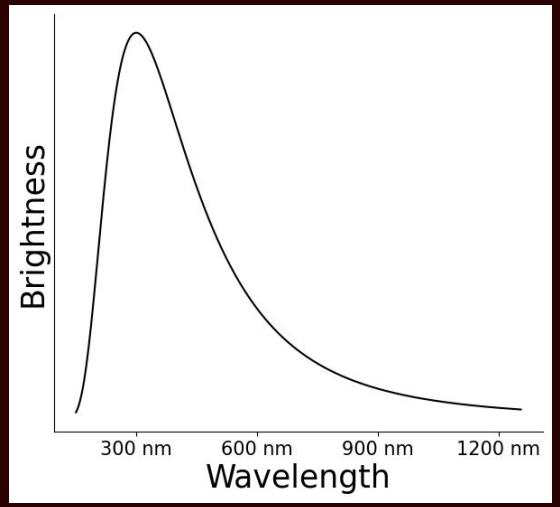
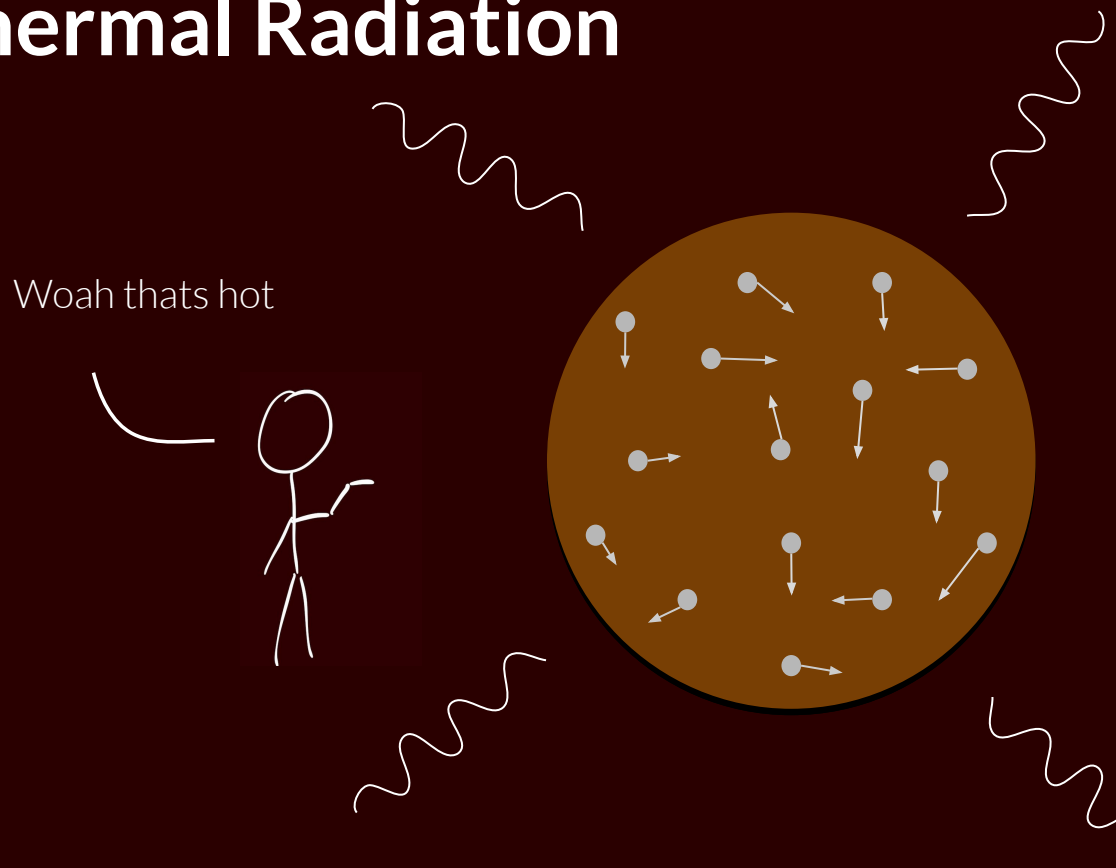




Thermal Radiation

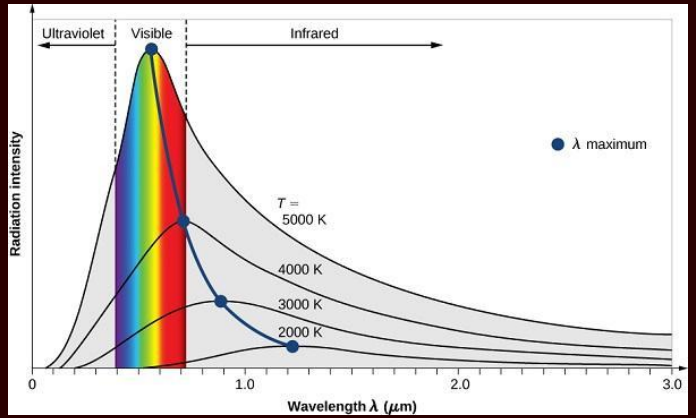
Key equations:

Stefan Boltzmann Eq.

$$L = A\varepsilon = 4\pi R^2 \varepsilon = 4\pi R^2 \sigma T^4$$

Wien's Law

$$\lambda_{peak} T = 2.9 \cdot 10^6 \text{ nm K}$$



Practice Problem

Suppose you observe two stars that have peak wavelengths of 200 nm and 300 nm. Which star is hotter? Sketch the blackbody spectra for the two stars on the same axes. What is the surface temperature of each star?

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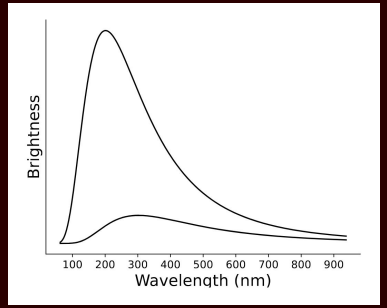

$$\lambda_{\text{peak}} T = 2.9 \cdot 10^6 \text{ nm K}$$

$$T_{\text{cooler}} = \frac{2.9 \cdot 10^6 \text{ nm K}}{300 \text{ nm}} = 9667 \text{ K}$$

$$T_{\text{hotter}} = \frac{2.9 \cdot 10^6 \text{ nm K}}{200 \text{ nm}} = 14500 \text{ K}$$

Questions?

Attendance checkout:

See ya next time!