

ASTR 1120: Stars & Galaxies



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Lecture 3 Fri 14 Jan 05
zeus.colorado.edu/astr1120-toomre

Topics for Today

- Scientific notation
- Coupling of atoms and light
- Electrons pop from one level to another
- Yields 'spectral lines' that are fingerprints unique to each atom
- "Kirchoff's Laws" about emission and absorption features in spectra

Reading for Next Class (Wed)

- Finish reading Chap 6, *Light*
- Start reading Chap 7, *Telescopes*
- Check with us if any problems with your clickers (fully in use Wed 19 Jan)
- Homework 1 due in class Fri 21 Jan

Clicker Tryout

Which year at CU are you in?

- A. Freshman
- B. Sophomore
- C. Junior
- D. Senior
- E. Other, and still enjoying it

SCIENTIFIC NOTATION

(need compact notation given vast range of scales)

SCIENTIFIC NOTATION

to avoid writer's cramp in astronomy
... $1/1000 = 10^{-3}$, $100 = 10^2$

ELECTROMAGNETIC FORCE IS

1,000,000,000,000,000,000,000,000,000,000,
000,000,000,000
(39 ZEROS)

= 10^{39} x STRONGER THAN GRAVITY

C.U. BUDGET: 400 MILLION DOLLARS = 4×10^8

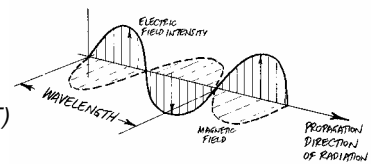
U.S. DEFICIT: 200 BILLION DOLLARS = 2×10^{11}

$$\frac{\text{C.U. BUDGET}}{\text{U.S. DEFICIT}} = \frac{4 \times 10^8}{2 \times 10^{11}} = 2 \times 10^{-3}$$

$$= 2 \times 0.001 = 2 \text{ ONE-THOUSANTHS}$$

(REMINDER)

ELECTROMAGNETIC RADIATION AS A WAVE



E-M (LIGHT) AS WAVES

$$\lambda \times f = c$$

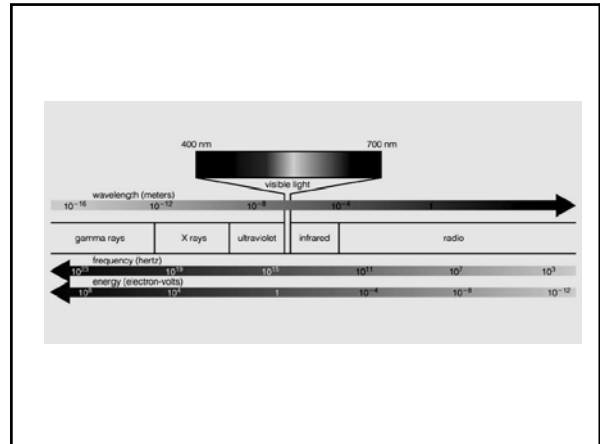
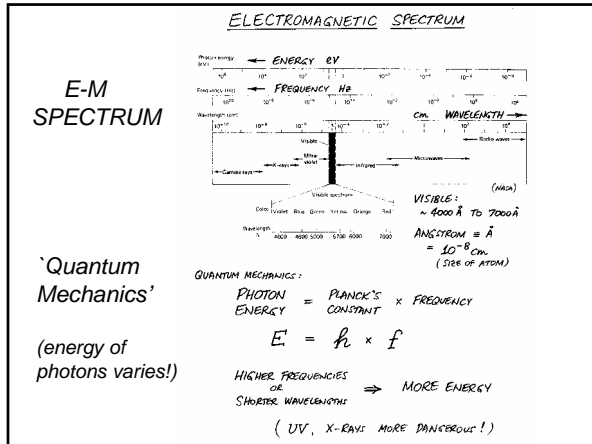
WAVELENGTH x FREQUENCY = SPEED OF "LIGHT"

$$\lambda = c/f, \quad f = c/\lambda$$

Speed of light SAME for all wavelengths

PROPAGATION SPEED OF ALL EM WAVES IS THE SAME!

$$c \text{ IS A CONSTANT} \approx 300,000 \text{ km/sec} \\ = 3 \times 10^{10} \text{ cm/sec}$$



Discussion Clicker Q

Is Extra-Sensory Perception (ESP), or telepathy, possible ... or is it nutty?

- Pretty unlikely (No)
- Sure, I believe it (Yes)
- Darned if I know (and why ask this in astronomy)
- How could such "communication" be carried out? (Interested)
- I prefer to sleep, wake me when its over

ATOMS

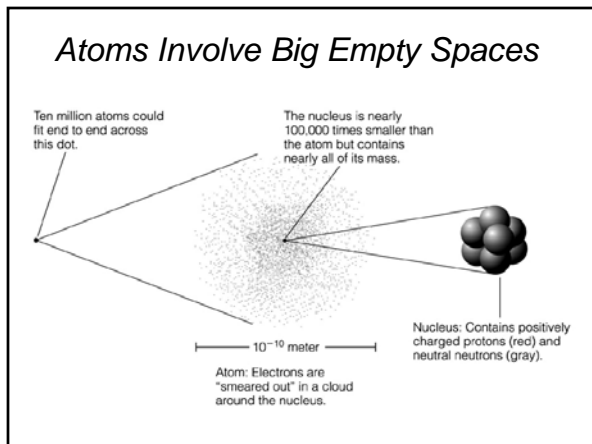
NUCLEI: POSITIVELY CHARGED PROTONS AND UNCHARGED NEUTRONS
OUTER SHELL(S) OF NEUTRALLY CHARGED ELECTRONS

ATOMS
 protons, neutrons, electrons
 (and quarks ...)

HYDROGEN
 ONE PROTON, NO NEUTRONS, ONE ELECTRON
 BUT ELECTRONS CAN BE IN ONE OR MANY DIFFERENT ORBITS, WITH DIFFERENT ENERGIES

HELIUM
 TWO OF EACH
 (ALSO ISOTOPES WITH ADDITIONAL NEUTRONS)

CARBON
 SIX OF EACH
 NUCLEI REALLY VERY SMALL (10^{-8} Å)



ORBITS OF ELECTRONS

POSSIBLE ORBITS FOR ELECTRON IN HYDROGEN ATOM (Bohr)

TRANSITIONS (USUALLY) EMIT OR ABSORB PHOTON

ORBITS OF ELECTRONS

Popping from one orbit to another involves particular PHOTONS
 (like DNA prints)

ONLY LIGHT OF CERTAIN COLORS (ENERGIES) CAN BE ABSORBED OR EMITTED

EACH CHEMICAL ELEMENT HAS ITS OWN UNIQUE NUMBER AND PATTERN OF ELECTRON ORBITS \Rightarrow UNIQUE PATTERN OF COLORS (SPECTRAL LINES ARE LIKE A FINGERPRINT!)

