Lecture 13

Astronomy Picture of the Day: Rosette Nebula

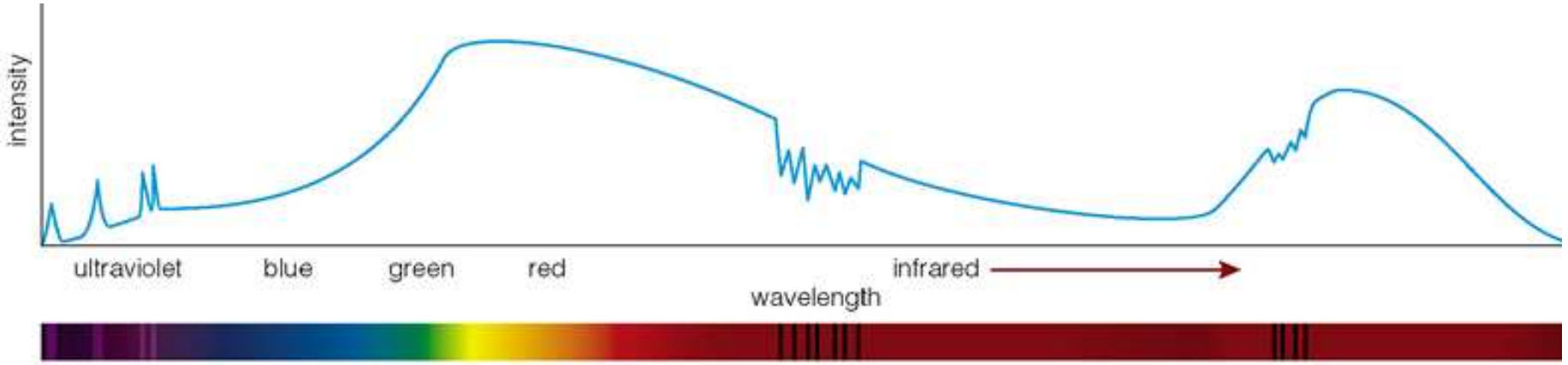
Lecture 13: Announcements

- Selected notes from lectures 11+12 online
  http://www.as.utexas.edu/~sj/a301-sp05.html

- Homework assignment due Monday by noon. No late HW accepted.

- Help available during office hours
  Nick Sterling out of town. Contact Nairn Baliber or myself

A Spectrum



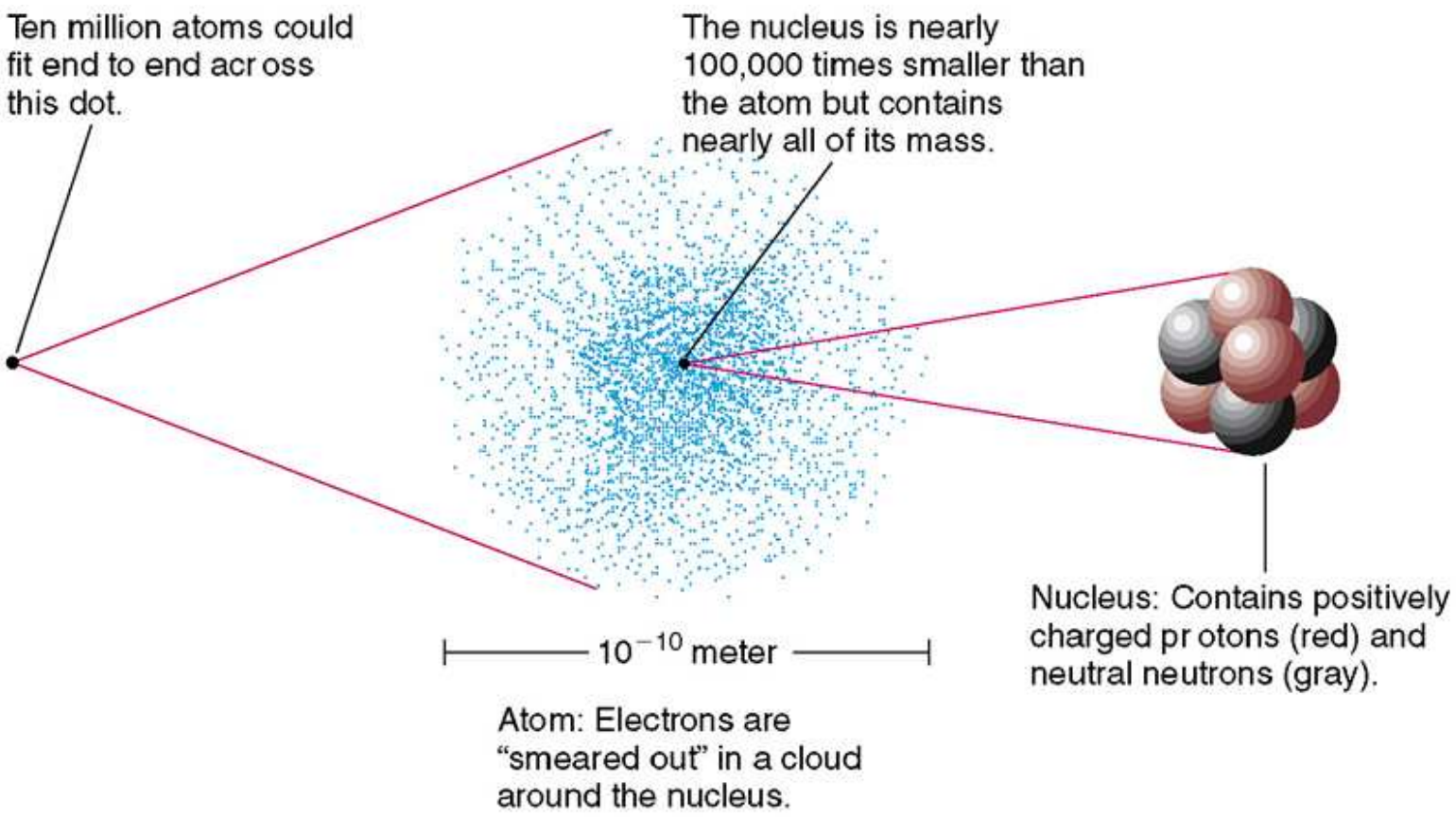
Continuum emission, Emission Lines, Absorption lines

Bright lines = higher intensity emission lines onto continuum

Dark ‘bands = absorption of light from underlying contnuum

?? How do we explain these features??

Structure of an Atom



Atom = Nucleus made of neutrons (neutral) and protons (+ve) , surrounded by a cloud of negatively charged electrons

No of protons = No of electrons = Atomic Number à Net charge = 0

Structure of an Atom

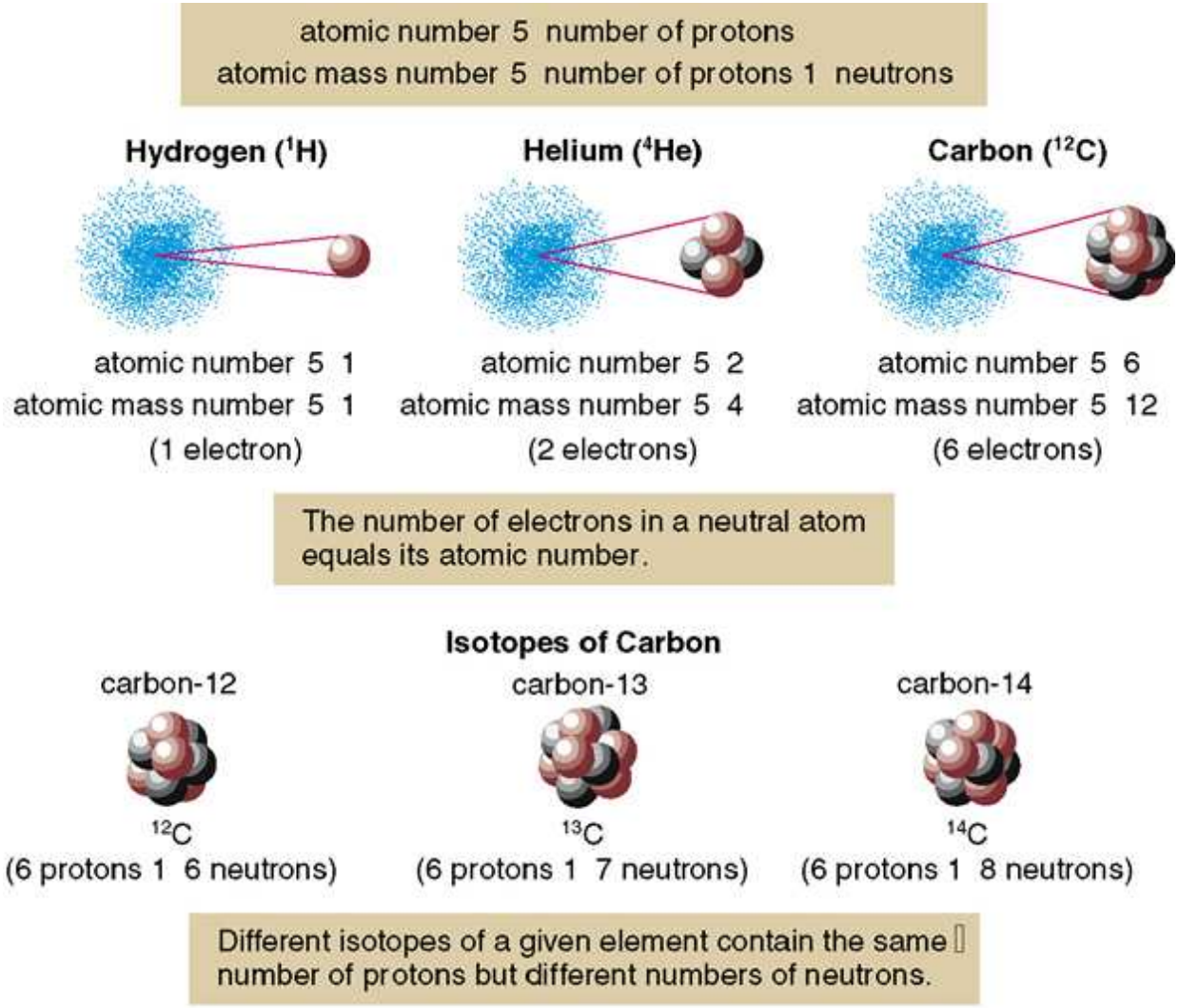
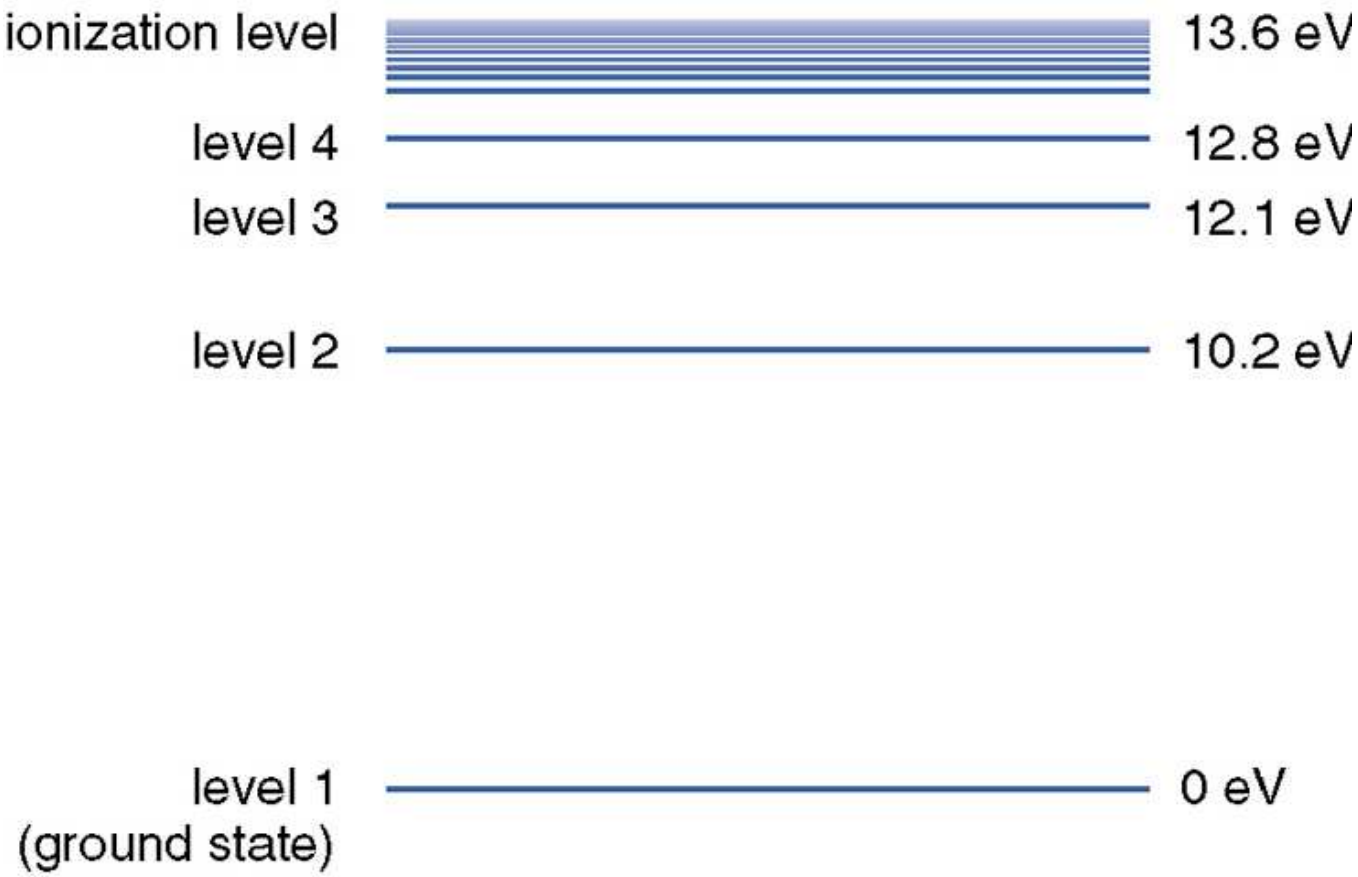


Figure captions are misprinted in book : "5" should be "=", "1" should be "+"

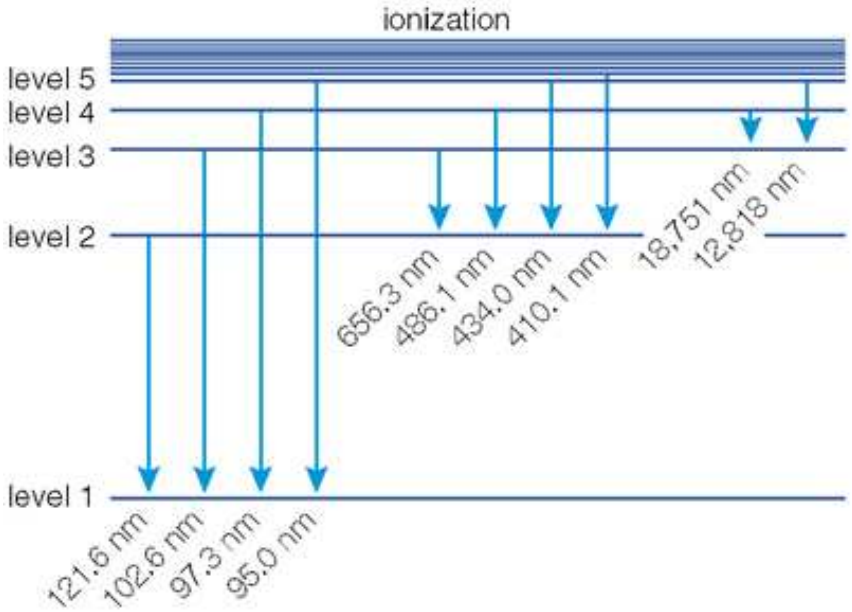
E.g., 2nd caption should read : atomic mass number = number of protons + neutrons

Structure of an Atom



Electrons in an atom can only populate certain discrete quantized energy levels
e, g., discrete levels for Hydrogen atom above

Emission and Absorption Lines from Atoms



- Electrons only move between discrete energy levels
- So only photons of specific energies (i.e. wavelengths) are emitted or absorbed by a given atom

Emission and Absorption Lines from Atoms

à In-class animation: “Production of Emission lines”

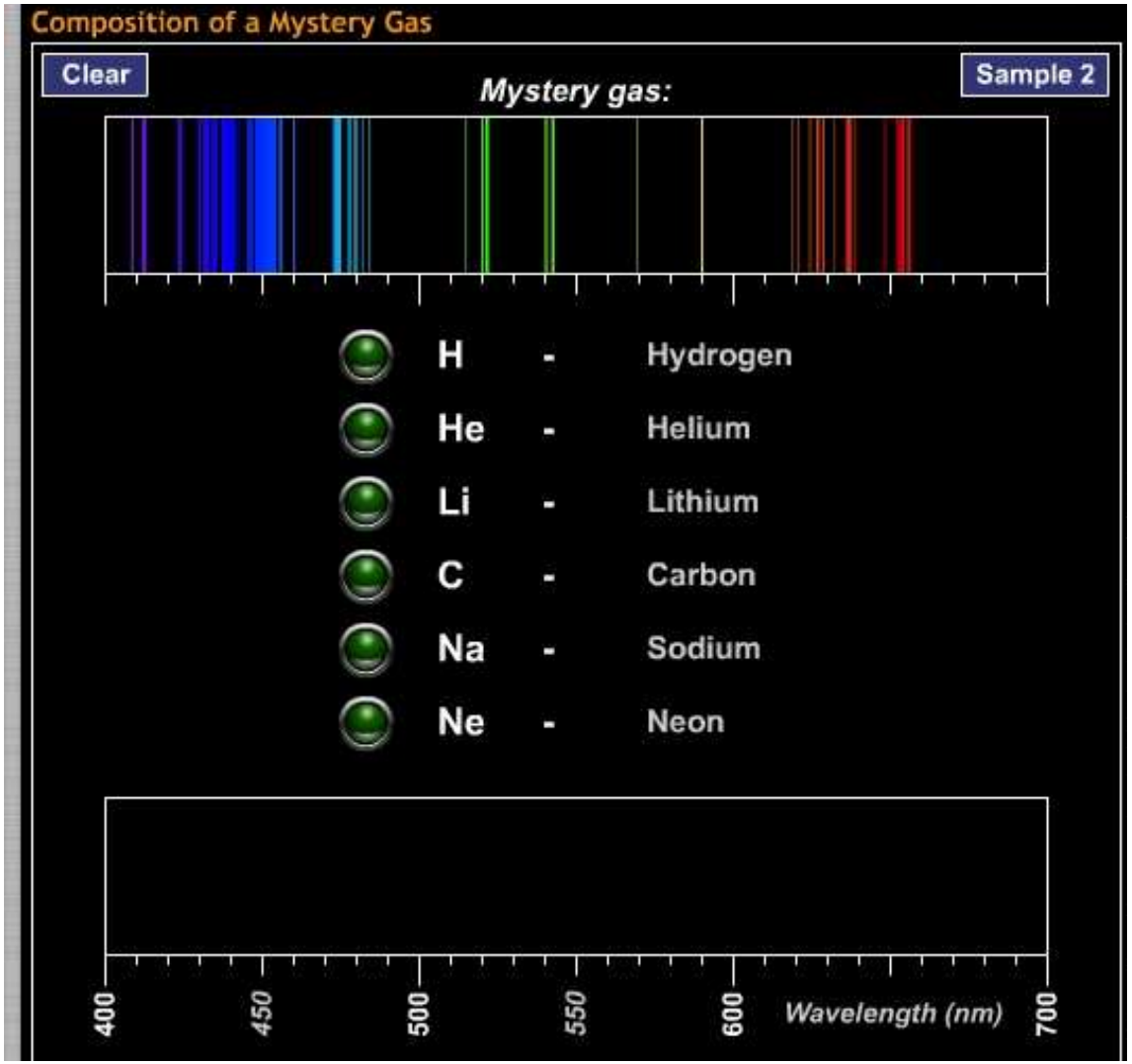
à In-class animation: “De-excitation of an atom and production of photons”

Characteristic Spectrum of Emission Lines from Atoms

Emission Spectra

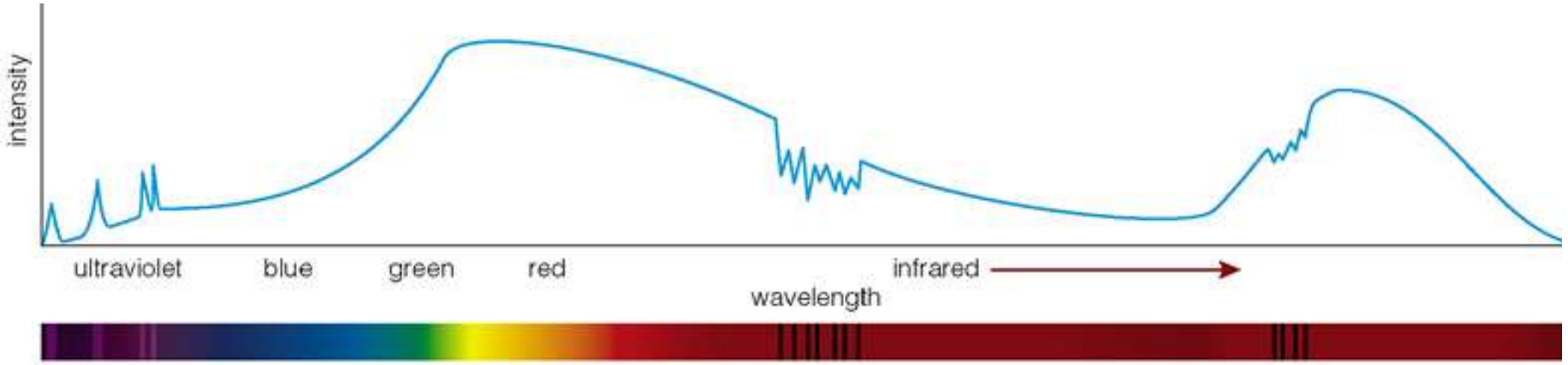
- à Unique and characteristic set of discrete emission lines at specific wavelengths for a given atom
- à Fingerprint / DNA of an atom

Characteristic Spectrum of Emission Lines from Atoms



à In-class demo : Composition of Mystery gas

A Spectrum

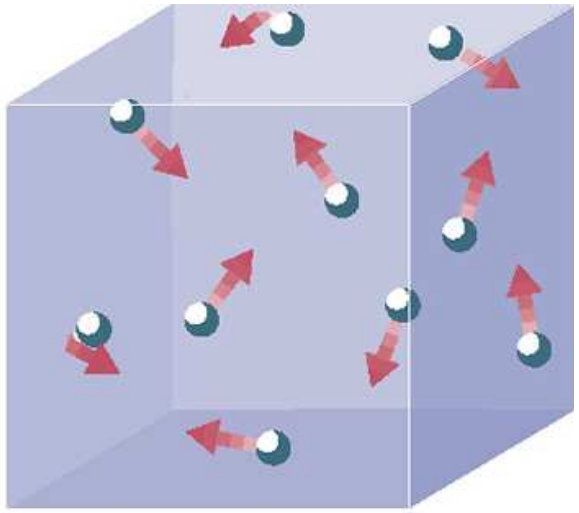


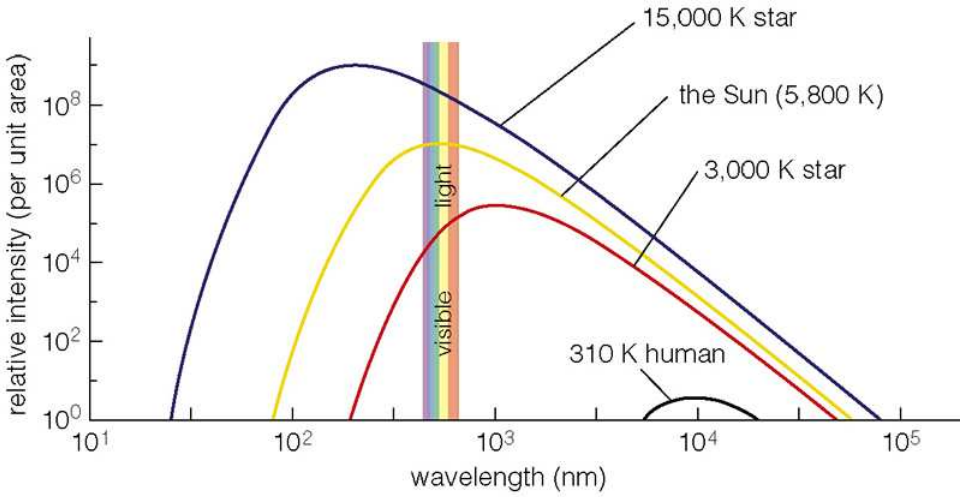
à the discrete emission lines are due to the emission of photons at specific wavelengths by bound electrons that move from a high to a low energy level

à the discrete absorption lines are due to the absorption of photons at specific wavelengths by bound electrons that move from a low to a high energy level

à But what produces the underlying continuum emission emitted over a continuous range of wavelengths?

Continuum or Thermal Emission





In a macroscopic body or blackbody at temperature T:

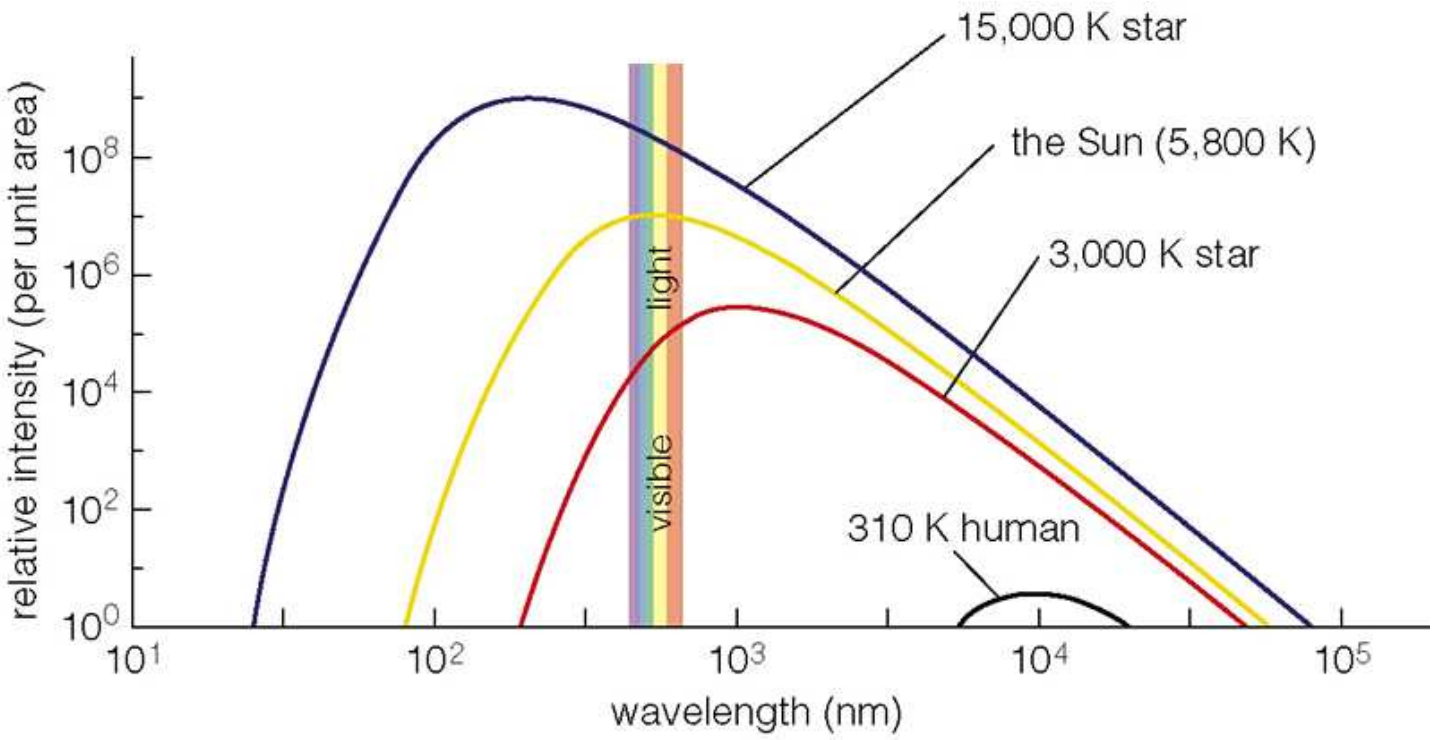
à Collision of many atoms randomizes their K.E.

à Mean KE of an atom depend only on the temparature T of the body

à When many atoms (with bound e-) collide at many different speeds, the electromagnetic interactions between charged particles (e-, H+) lead to the emission of **photons with a continuous range of wavelengths.**

à **The shape of resulting thermal or blackbody spectrum depends only on T.**

Wien's Law and Stefan-Boltzmann for Thermal Emission



The shape of a thermal or blackbody spectrum depends only on the temperature T

Wien's Law for peak wavelength of spectrum: $\lambda_{peak} = W/T$

Stefan-Boltzmann law: Energy emitted per m^2 per second $= \sigma T^4$