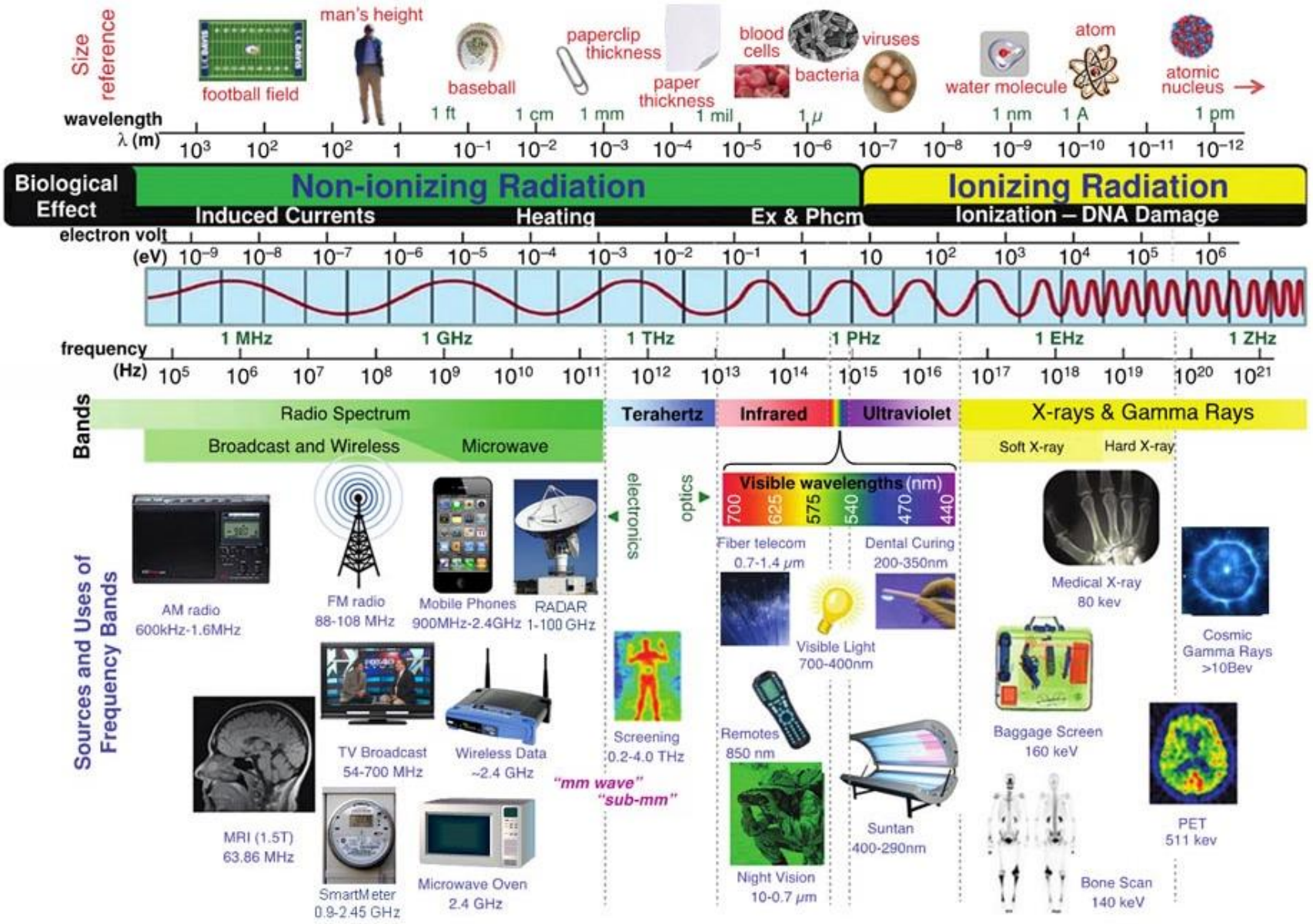
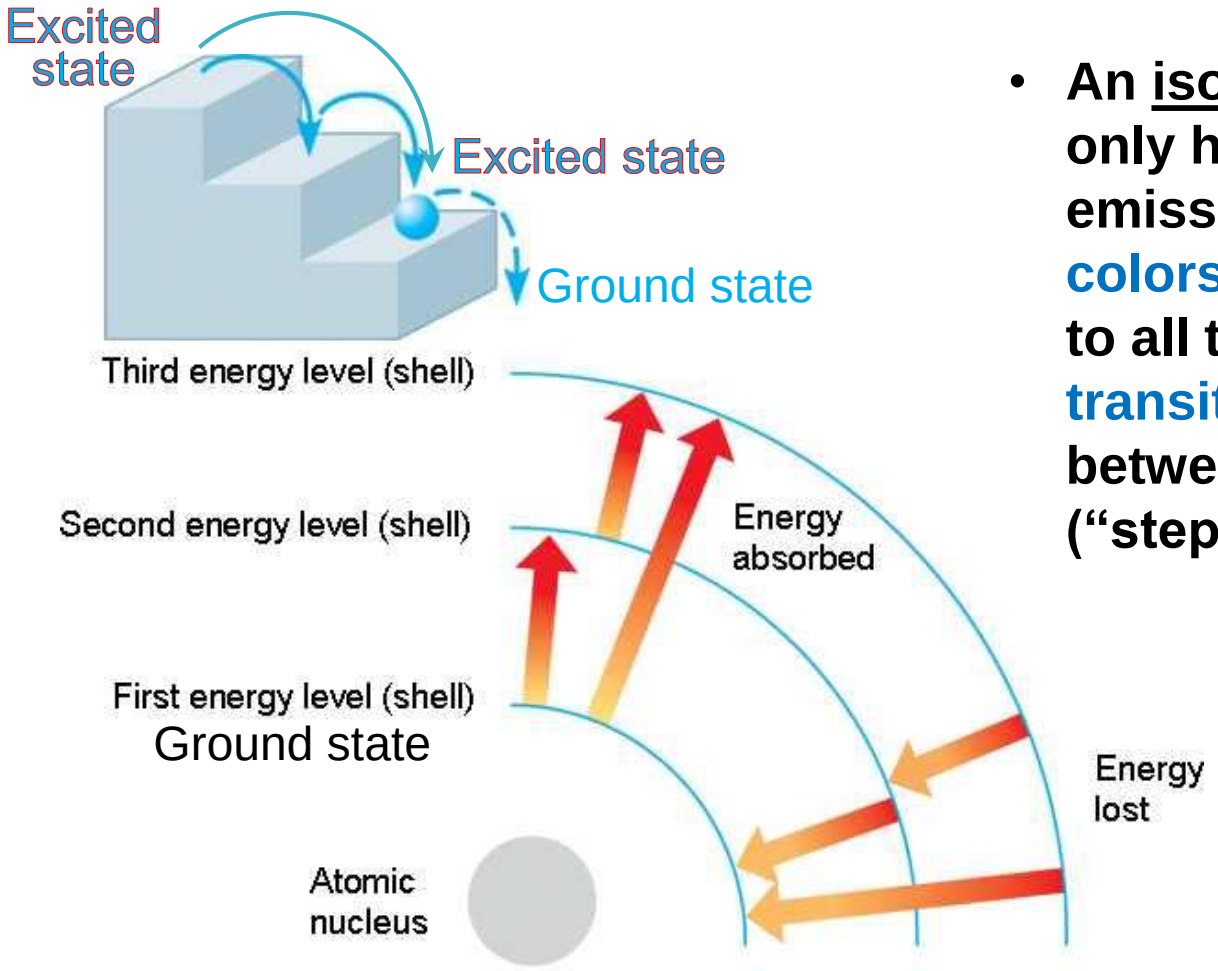
Light Emission Part 2



Electromagnetic Radiation

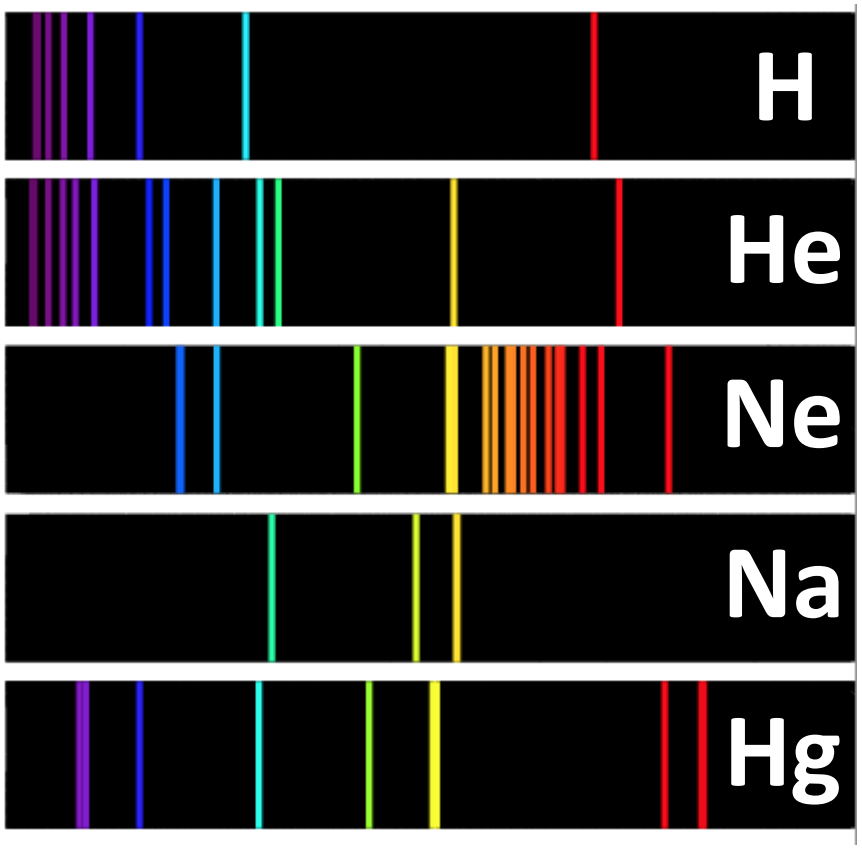
A *ball bouncing down a flight of stairs* provides an analogy for energy levels of electrons in atoms: it can only rest on each step, not between steps; the lowest possible step is "ground".



- **An <u>isolated atom</u> will only have light emissions of certain colors corresponding to all the allowed transitions of electrons between energy levels ("steps").**
- **This set of distinct colors is called *line emission spectrum*.**

Line Emission Spectrum

Each particular chemical element has a unique electron configuration and hence its own unique line emission spectrum, also called atomic spectrum.



- **Spectroscopy can be used to identify the elements in matter of unknown composition.**
- **Similarly, the emission spectra of molecules can be used in chemical analysis of substances.**
- **Emission spectra are given by matter in a gaseous state: the atoms or molecules are so far apart that they behave like they are isolated.**

Flame Test

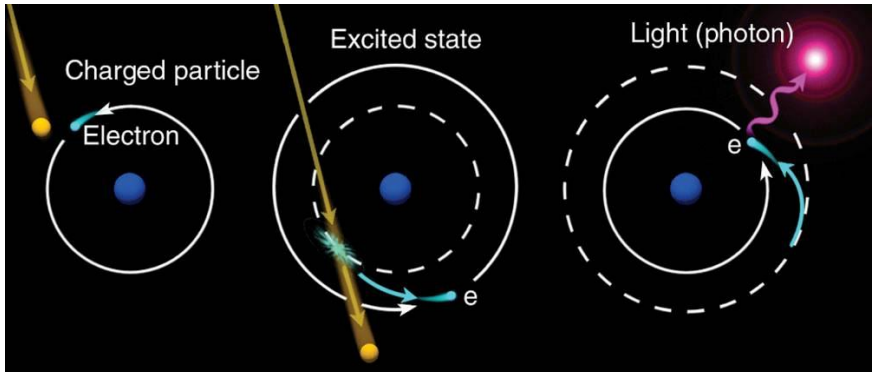
A flame test is an analytic procedure used in chemistry to detect the presence of certain elements, primarily metal ions, based on their unique emission spectrum.

The idea:

- introduce a sample into flame to *heat*
- sample atoms *sublimate* (get *isolated*)
- since they are *hot*, they ***emit light***

Aurora (Northern Lights)

The aurora forms when charged particles emitted from the Sun (solar wind) get caught up in the Earth's magnetic field and collide with atoms and molecules in the top of the atmosphere.

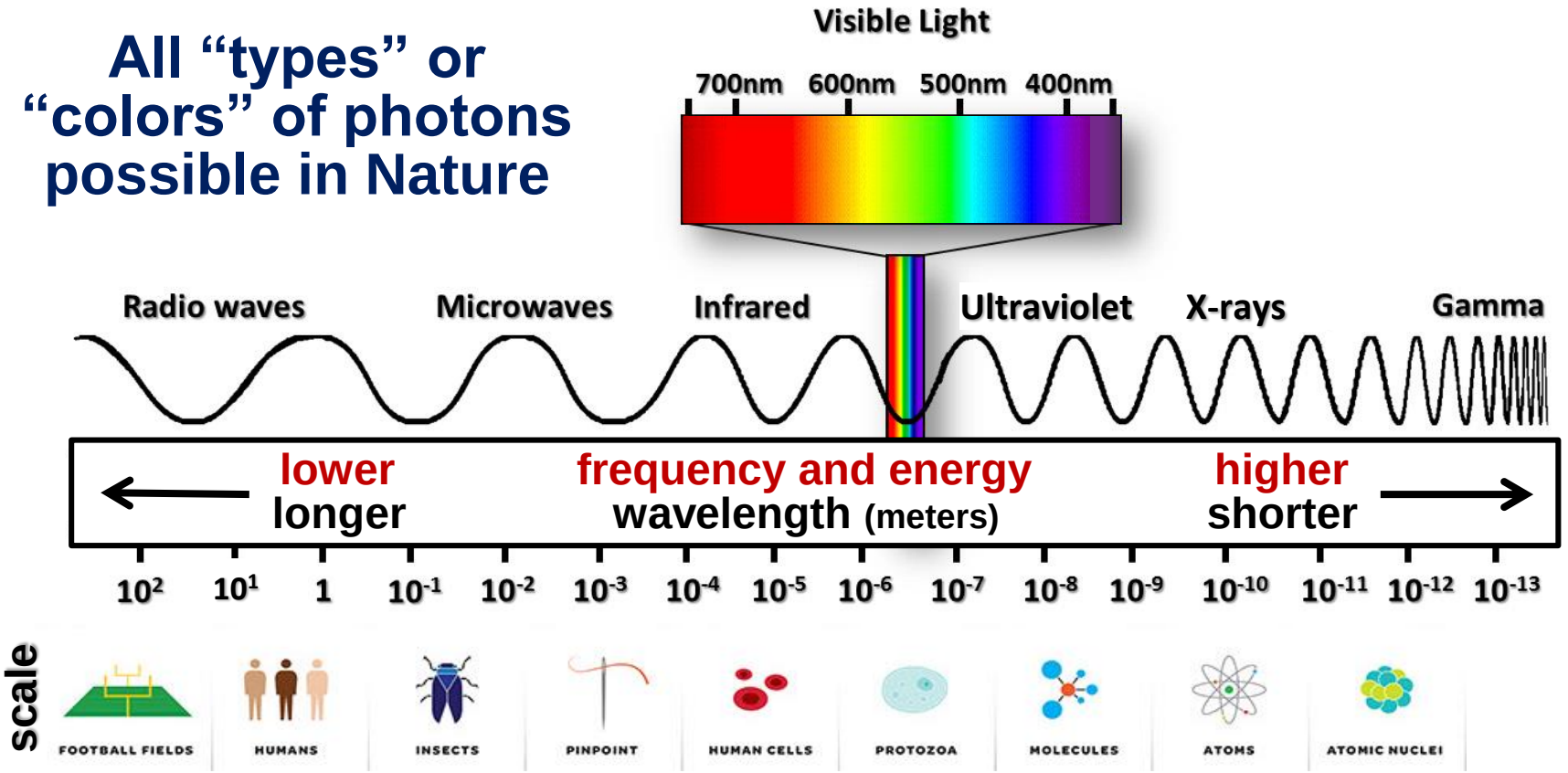


Different colors of the aurora are produced by different atmospheric components:

- **Red – oxygen atoms at ~200 miles high**
- **Blue – ionized nitrogen molecules**
- **Green-Yellow – oxygen atoms at ~60 miles high – most common!**
- **Pink/crimson/purple – mix of the above**

Electromagnetic Spectrum

All "types" or "colors" of photons possible in Nature



$$\text{Wavelength} = \frac{c}{\text{Frequency}}$$

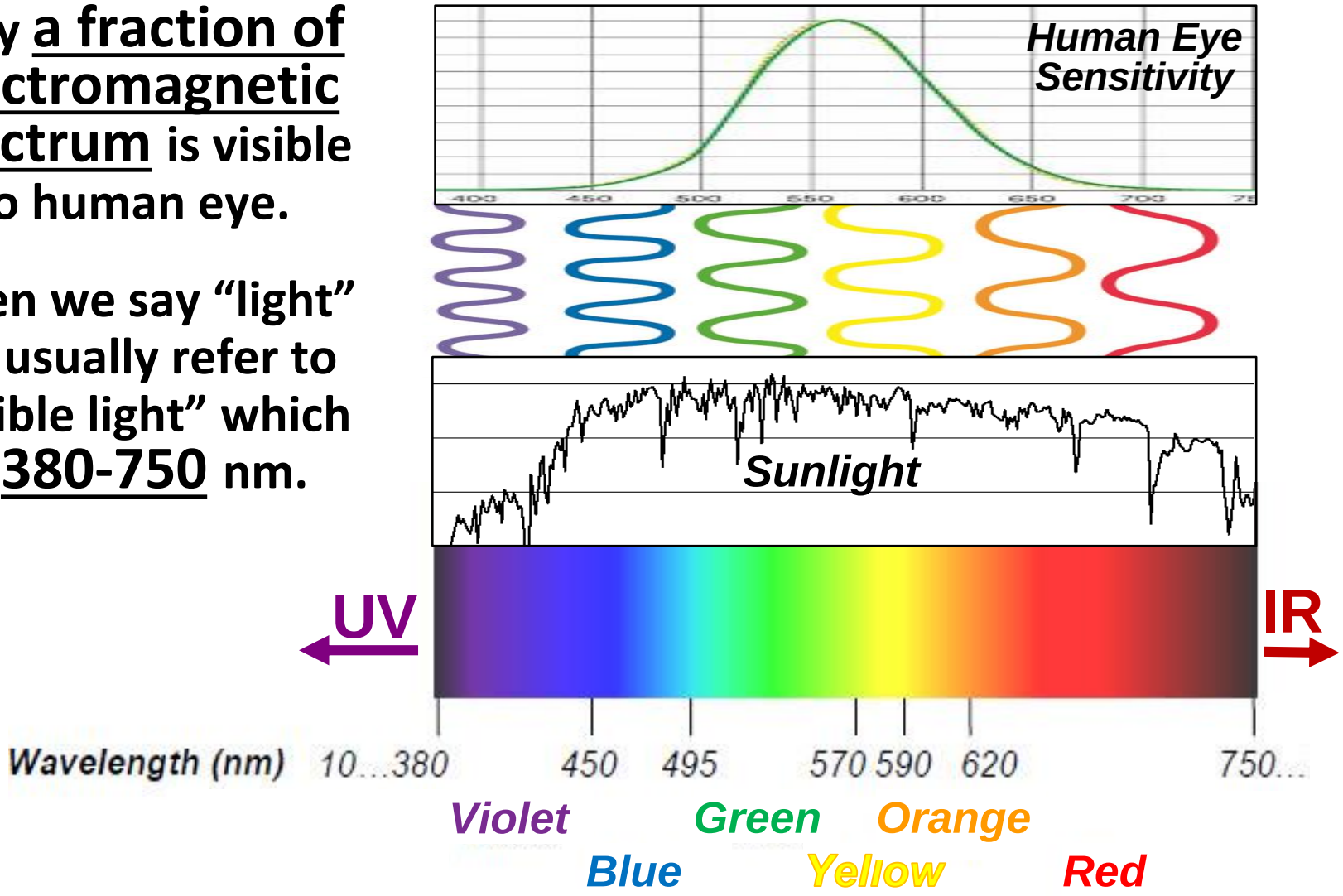
c is the speed of light

Energy ~ Frequency

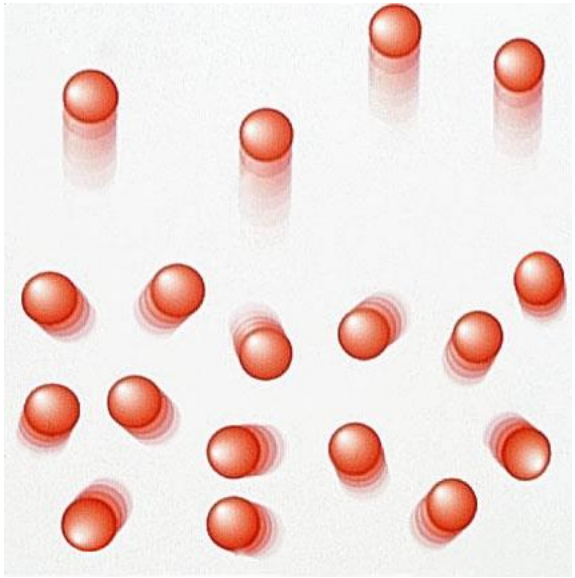
Visible Light

Only a fraction of electromagnetic spectrum is visible to human eye.

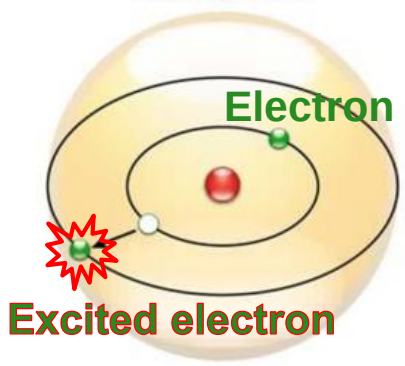
When we say "light" we usually refer to "visible light" which is 380-750 nm.



Gases

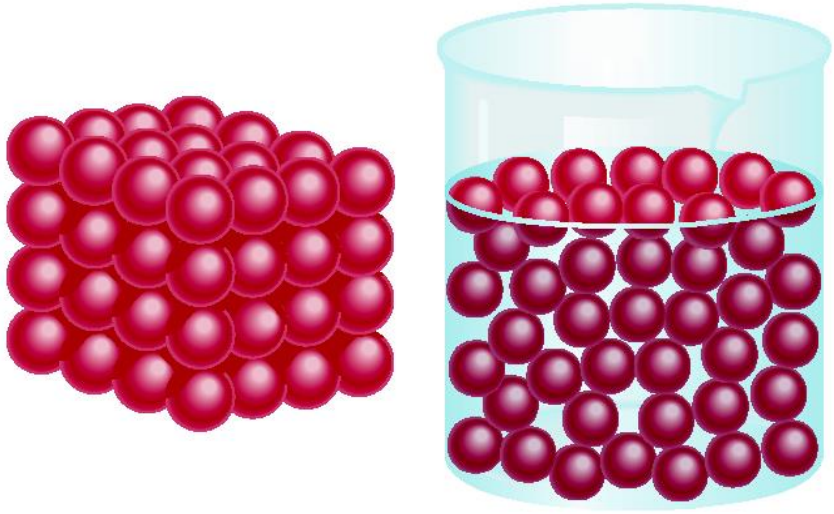


atoms far apart

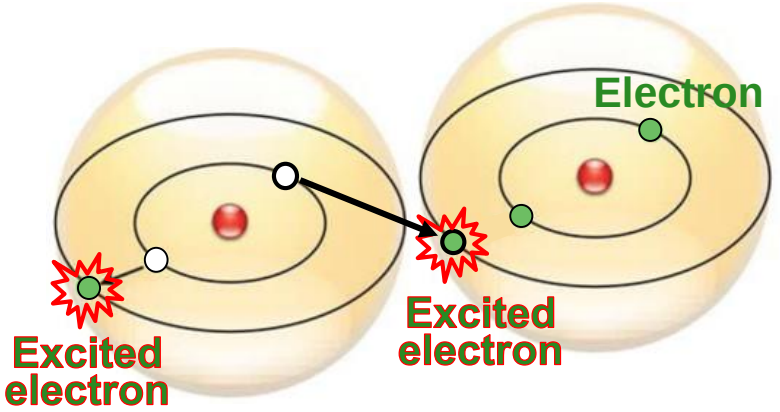


VS

Solids/Liquids



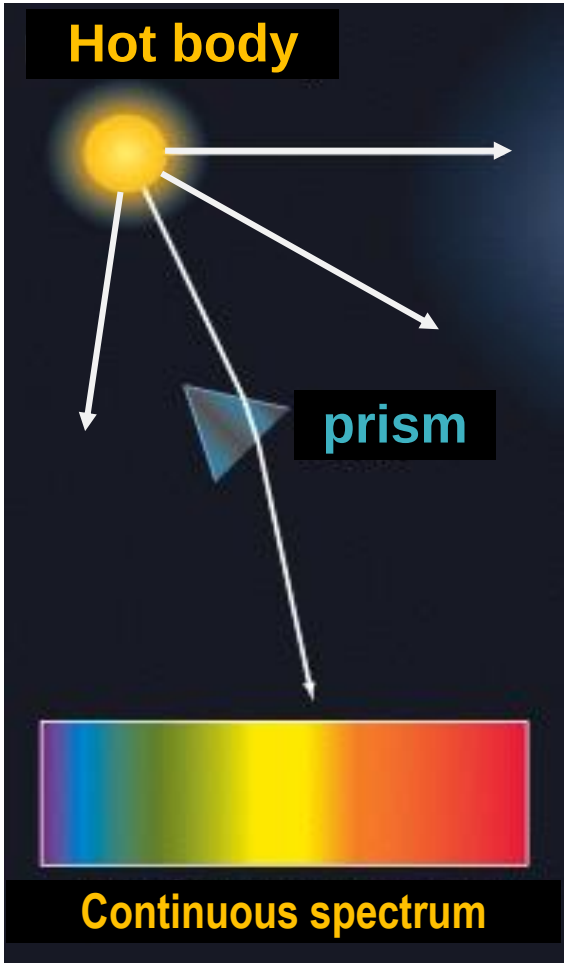
atoms close to each other



Thermal Radiation

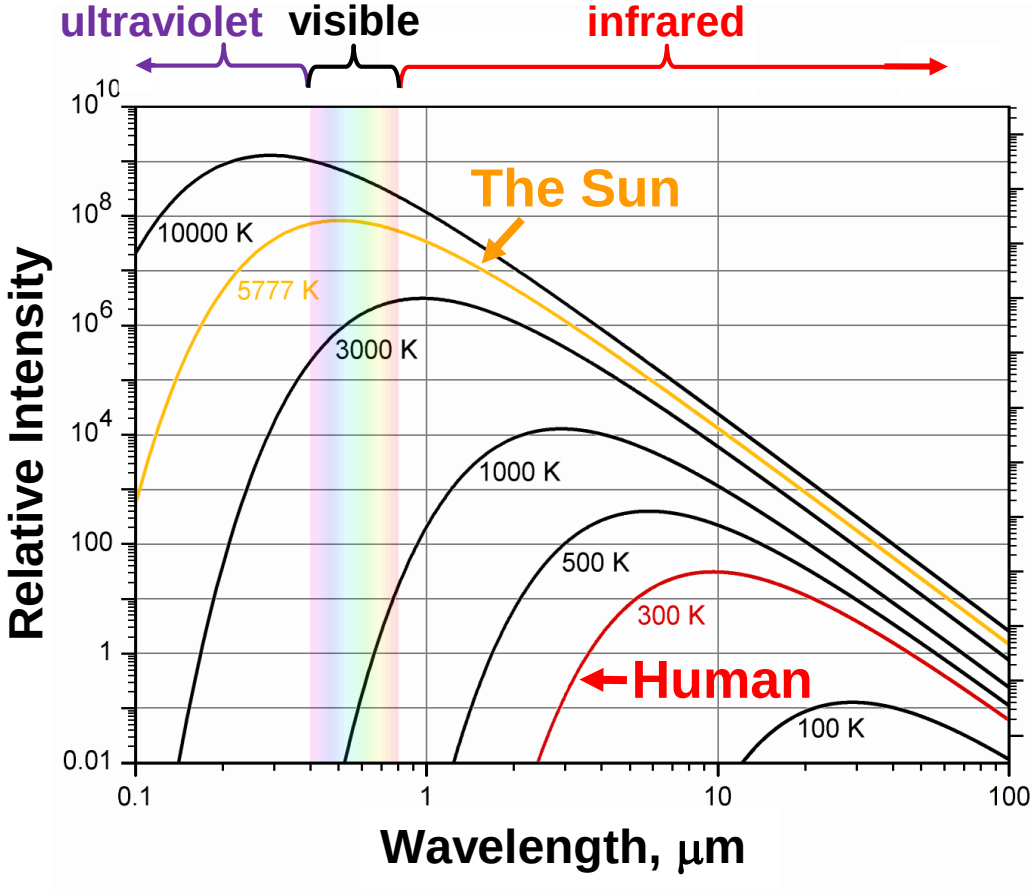
All normal matter emits electromagnetic radiation when it has a temperature above absolute zero.

- **This radiation represents a conversion of a body's thermal (heat) energy into electromagnetic energy, and is therefore called thermal radiation.**
- **When the atoms are in a condensed state (solid or liquid matter), the "hot" electrons can make transitions not only within the energy levels of their own atom, but also between the levels of neighboring atoms (that can be of same or different kind).**
- **This results in a much larger number of possible transitions with corresponding frequencies of radiant energy, producing a continuous color spectrum.**



Thermal Radiation Spectrum

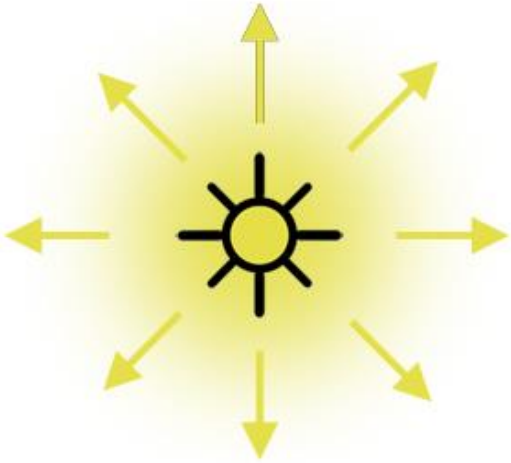
The exact thermal radiation spectrum depends upon properties of the material and the temperature. As the temperature decreases, the peak of the radiation curve moves to lower intensities and longer wavelengths.



- The temperature at which all solids glow a dim red is about 798 K (~976 F).
- A very hot object would emit a significant amount of energy in the ultraviolet region of the spectrum.
- People are emitters of energy in the infrared region (peak ~9.5μm).

How to Describe Light?

- **The intensity of light is the amount of energy falling on a surface per a unit of time.**
  - **"Amount" of photons.**
  - **Most light sources distribute their light equally in all directions, making a spherical pattern.**
  - **Because light spreads out in a sphere, the intensity decreases the farther you get from the source.**



- **The spectral composition of light is the relative light intensity for all emitted colors (wavelengths).**