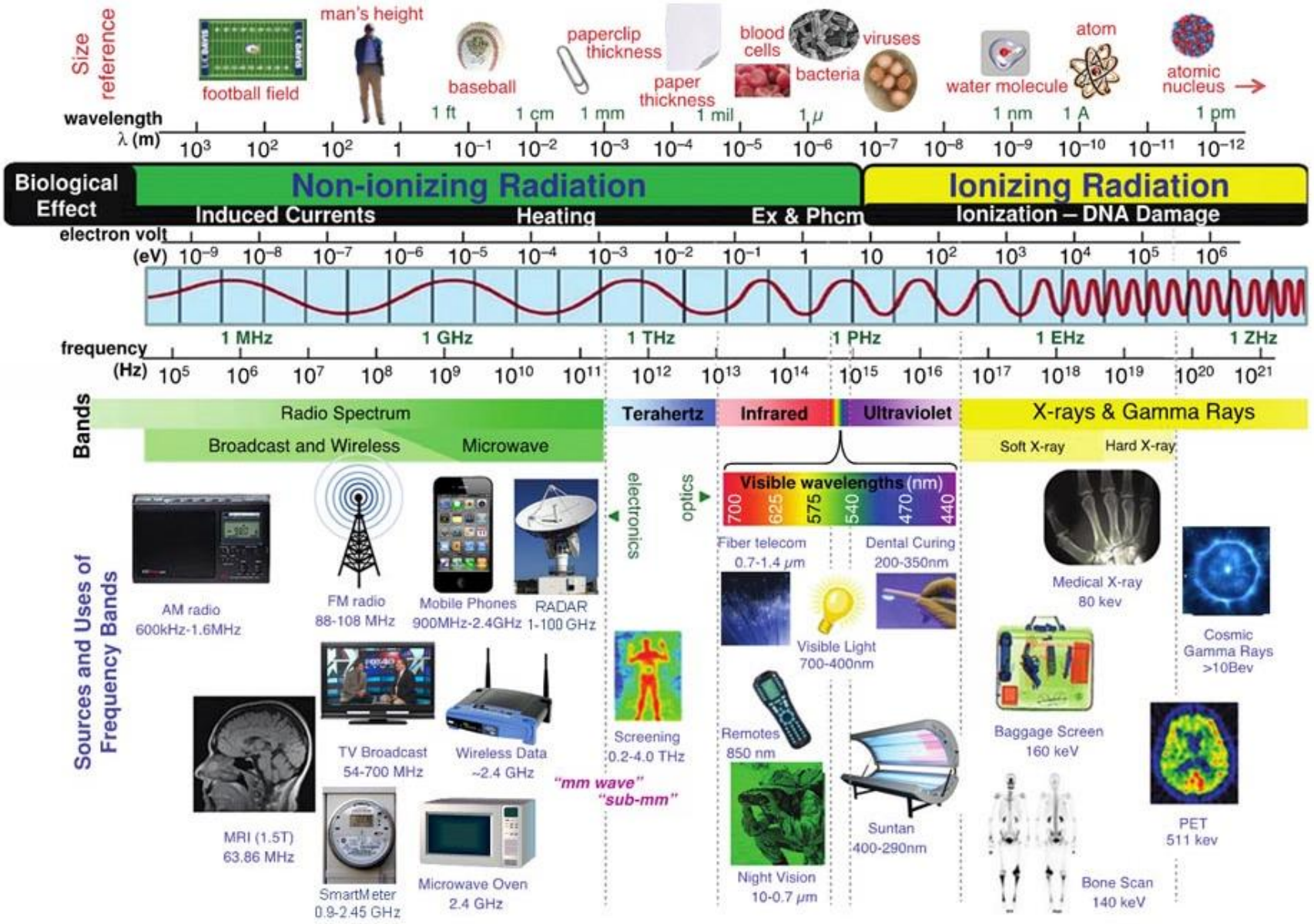
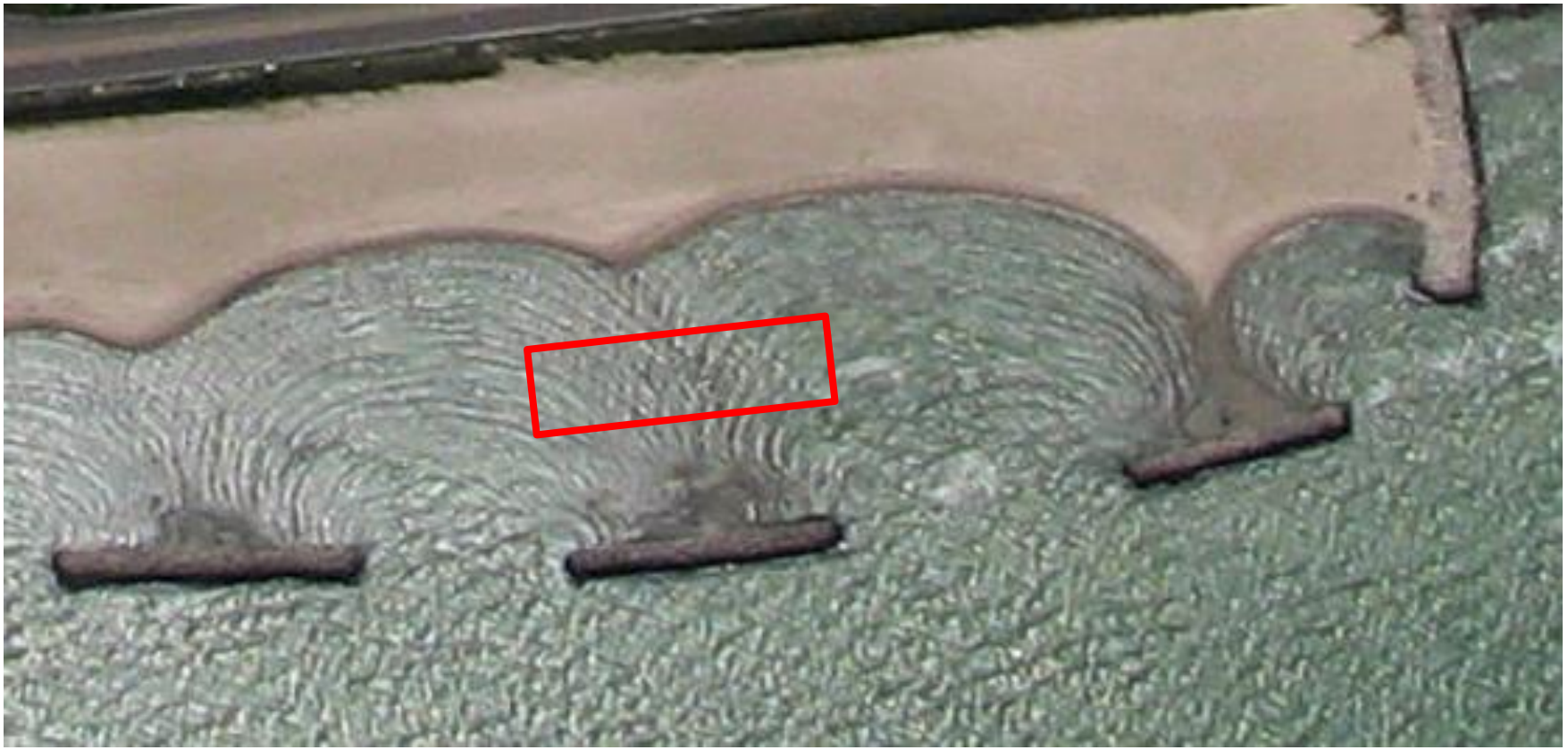
# Light Emission Part 1

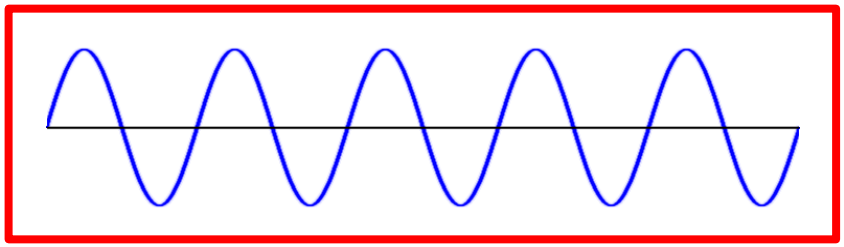


# Is This a Familiar Sight?

## Waves of Water in the Ocean



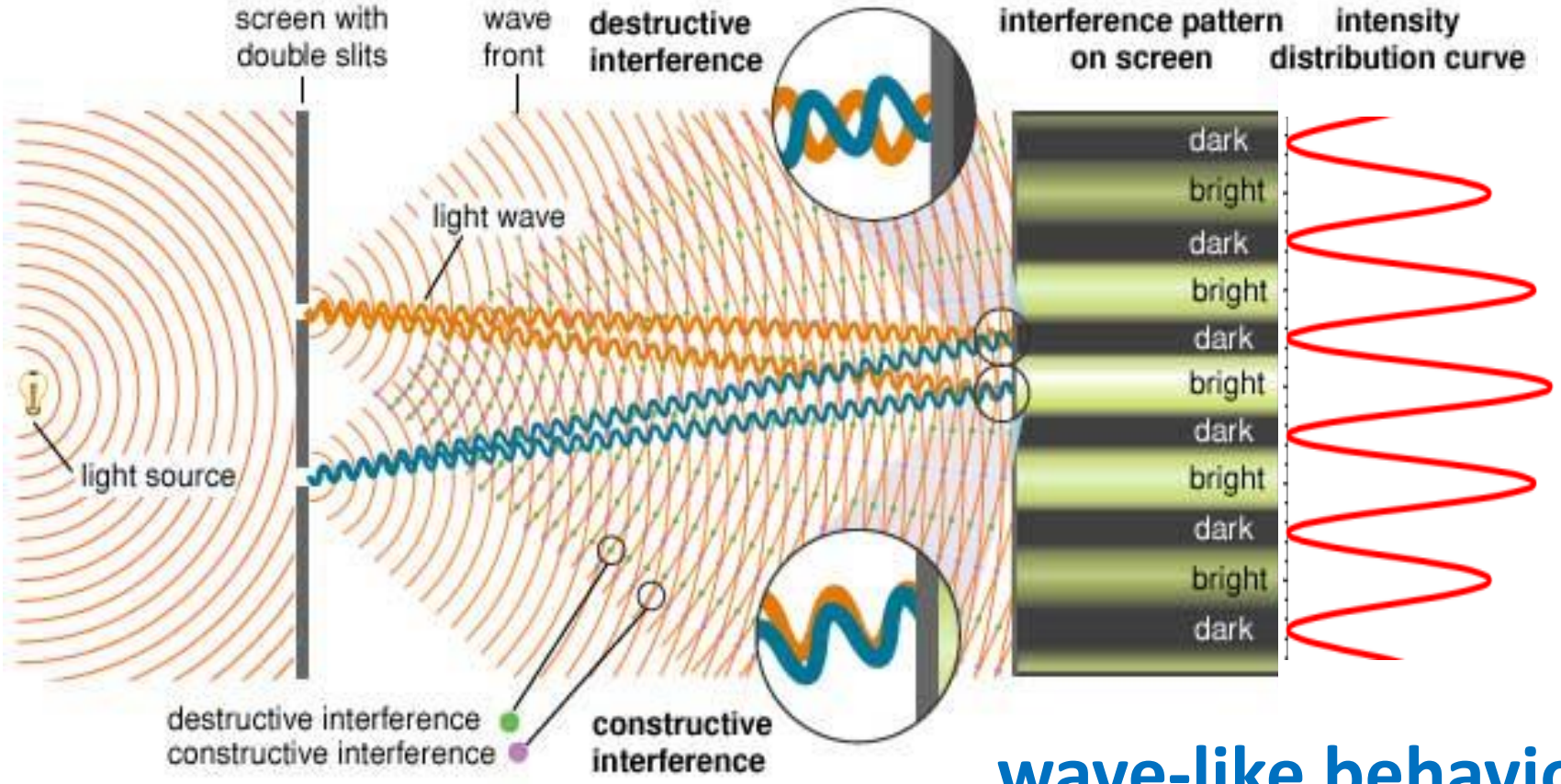
*"High-low" pattern behind the obstacle*



# Double-Slit Experiment

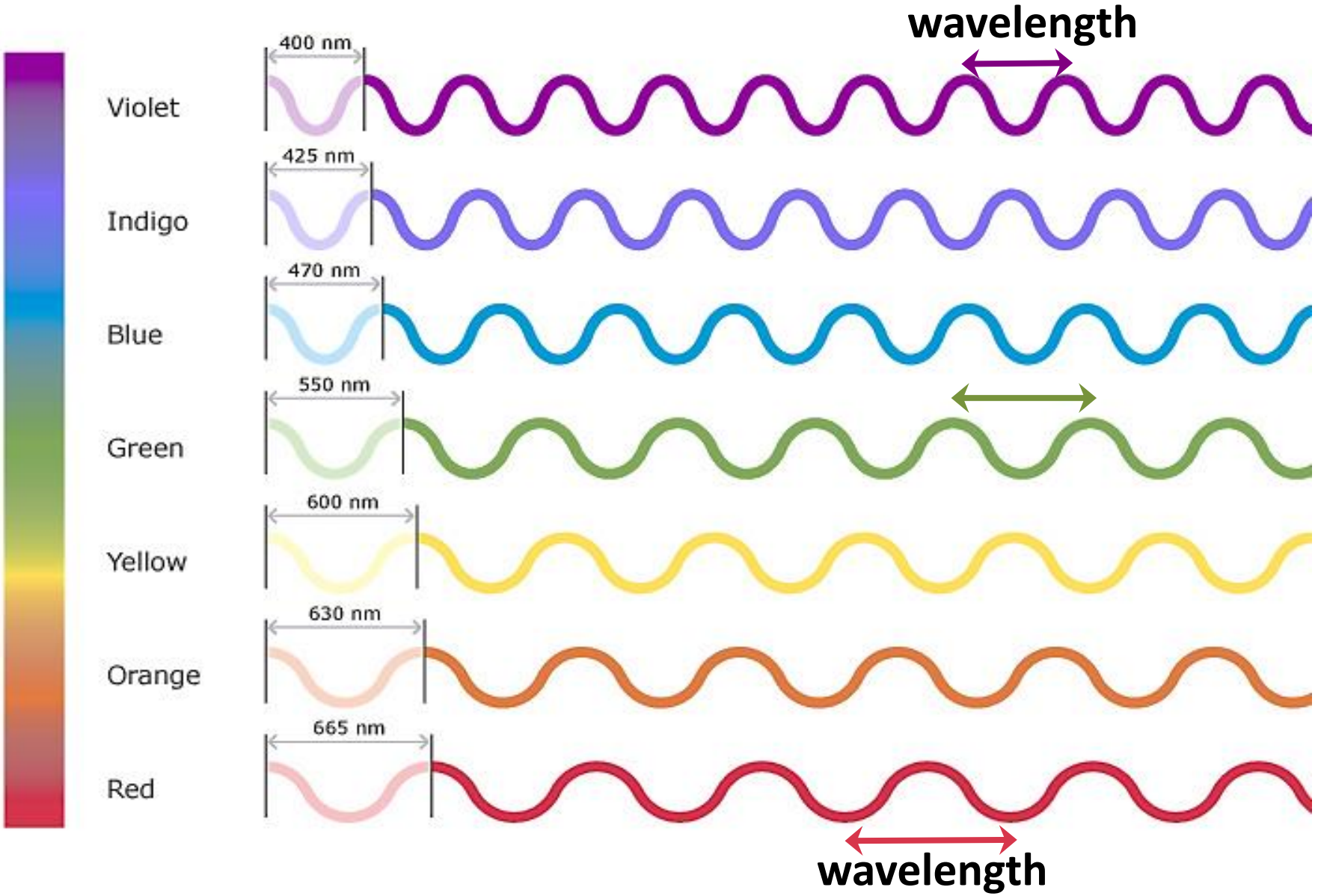
## Thomas Young, 1803

**Light passing through two parallel slits will interfere, producing a *pattern of bright and dark fringes*.**



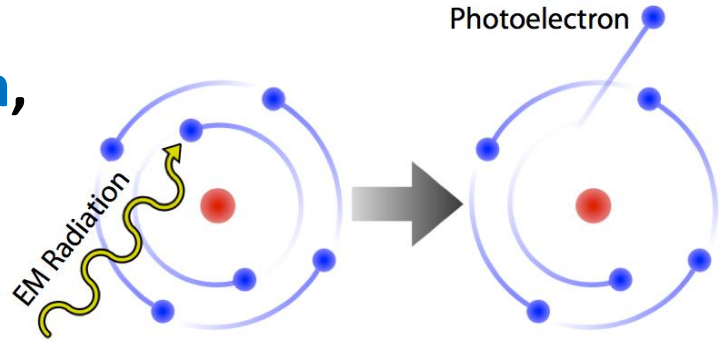

**wave-like behavior**

# Light as a Wave

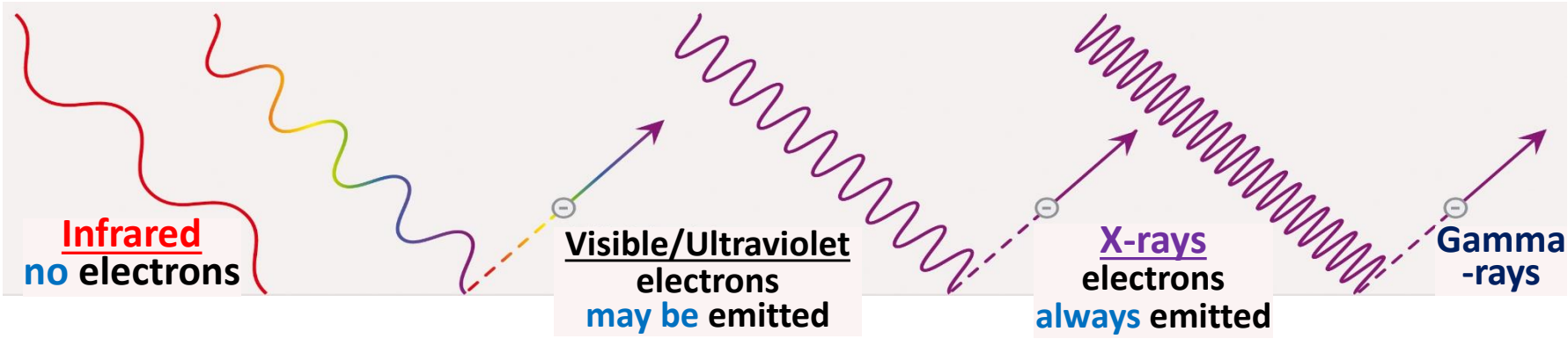


# Photoelectric Effect

**The photoelectric effect is the emission, or ejection, of electrons from the surface of a material (usually metal) in response to incident light.**



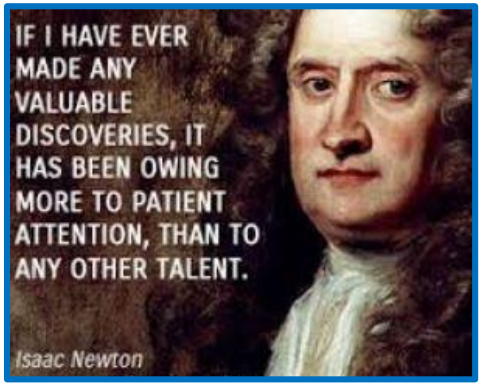

- **Heinrich Hertz, 1887: discovered that electrodes illuminated with ultraviolet light create electric sparks more easily (i.e. at lower applied voltage).**
- **Philipp Lenard, 1902: demonstrated that electrons are liberated from a metal surface when it is illuminated.**
- **For each material, it occurs only for light beyond a certain color.**



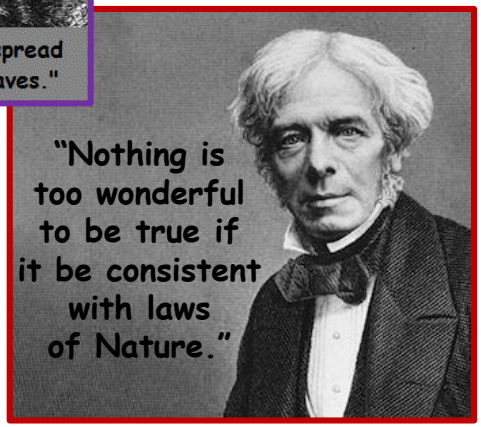

- **Could not be explained by classical physics (light as an electromagnetic wave).**
- **Einstein, 1905: photons, the particles of light (1921 Nobel Prize in Physics).**

# Nature of Light Debate

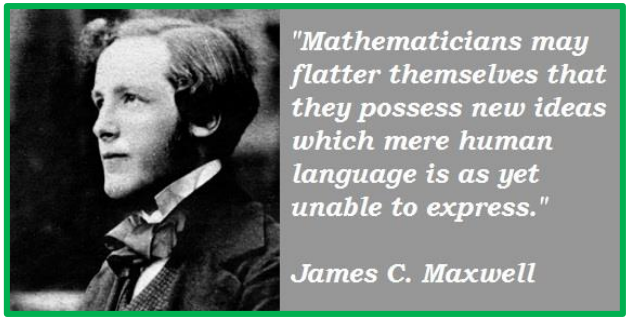
**Isaac Newton, 1675:**
light is made of particles of energy (corpuscles). Explained reflection, shadows, traveling in straight lines.



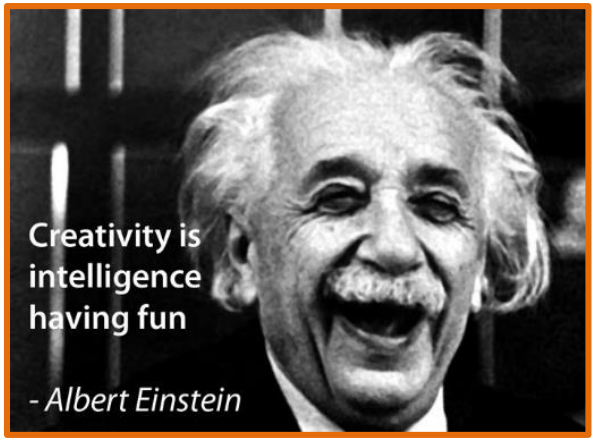

**Christiaan Huygens, 1678:**
light is made of waves in ether. Explained diffraction, interference.

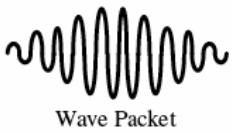

**Michael Faraday, 1847:**
light is a high-frequency electromagnetic vibration, which could propagate even in the absence of a medium.




**James Maxwell, 1864:**
light is an electromagnetic wave.



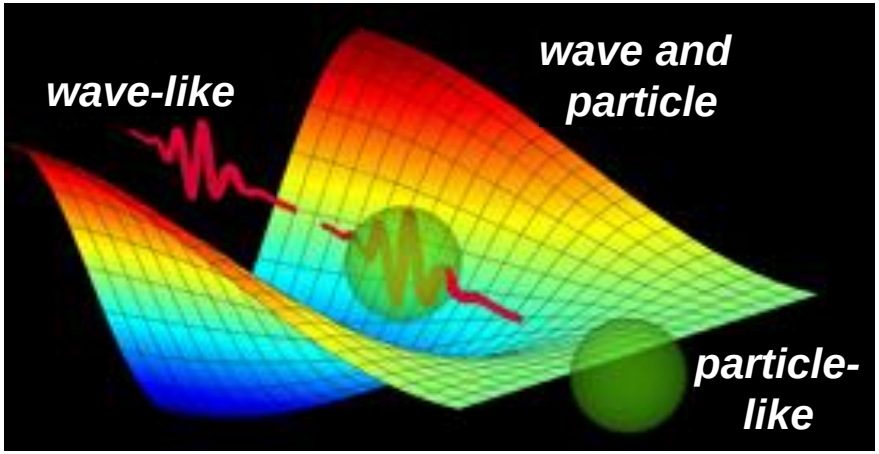

**Albert Einstein, 1905:**
a beam of light is not a continuous wave propagating through space, but rather a collection of discrete wave packets, photons.



# What is Light: Current View

- **Light is a form of energy that travels.**
- **Light has a dual nature:**
  - **wave properties (propagation)**
  - **particle properties (emission/absorption)**
- **Light waves do not need a medium to propagate.**
- **Light waves are electromagnetic radiation.**
- **Light particle, a photon, has *zero mass*.**

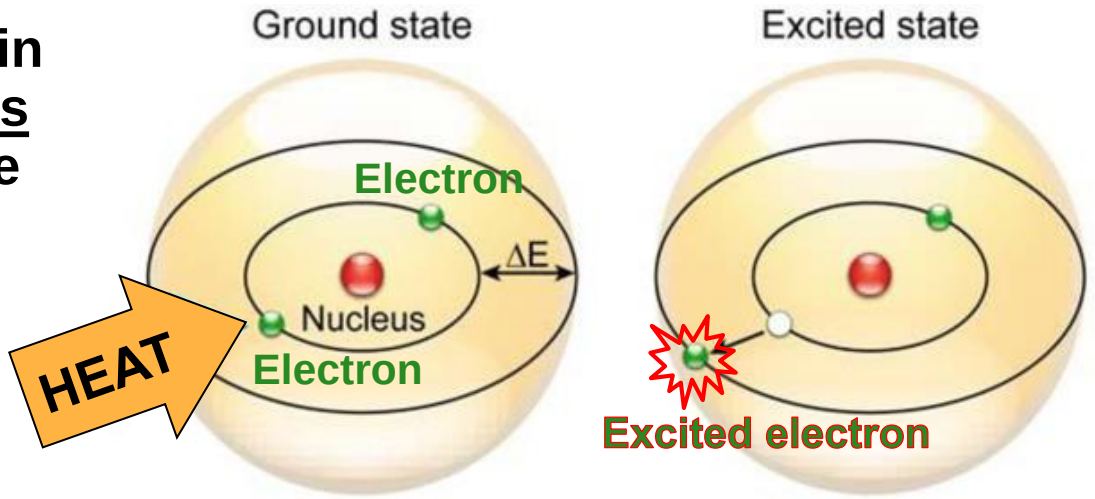
***The actual nature of the photon is not really describable in terms that are very descriptive…***

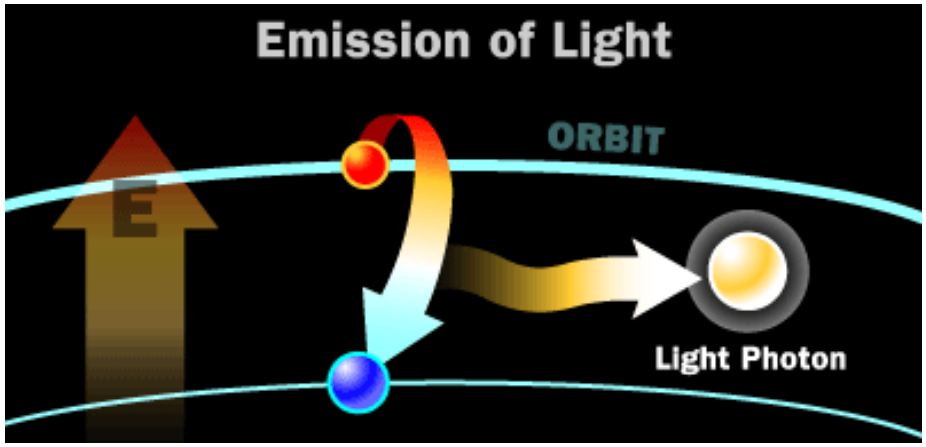


# Electromagnetic Radiation

**Emission of <u>electromagnetic radiation</u> results from oscillations of electrons ("jumps" between energy levels).**

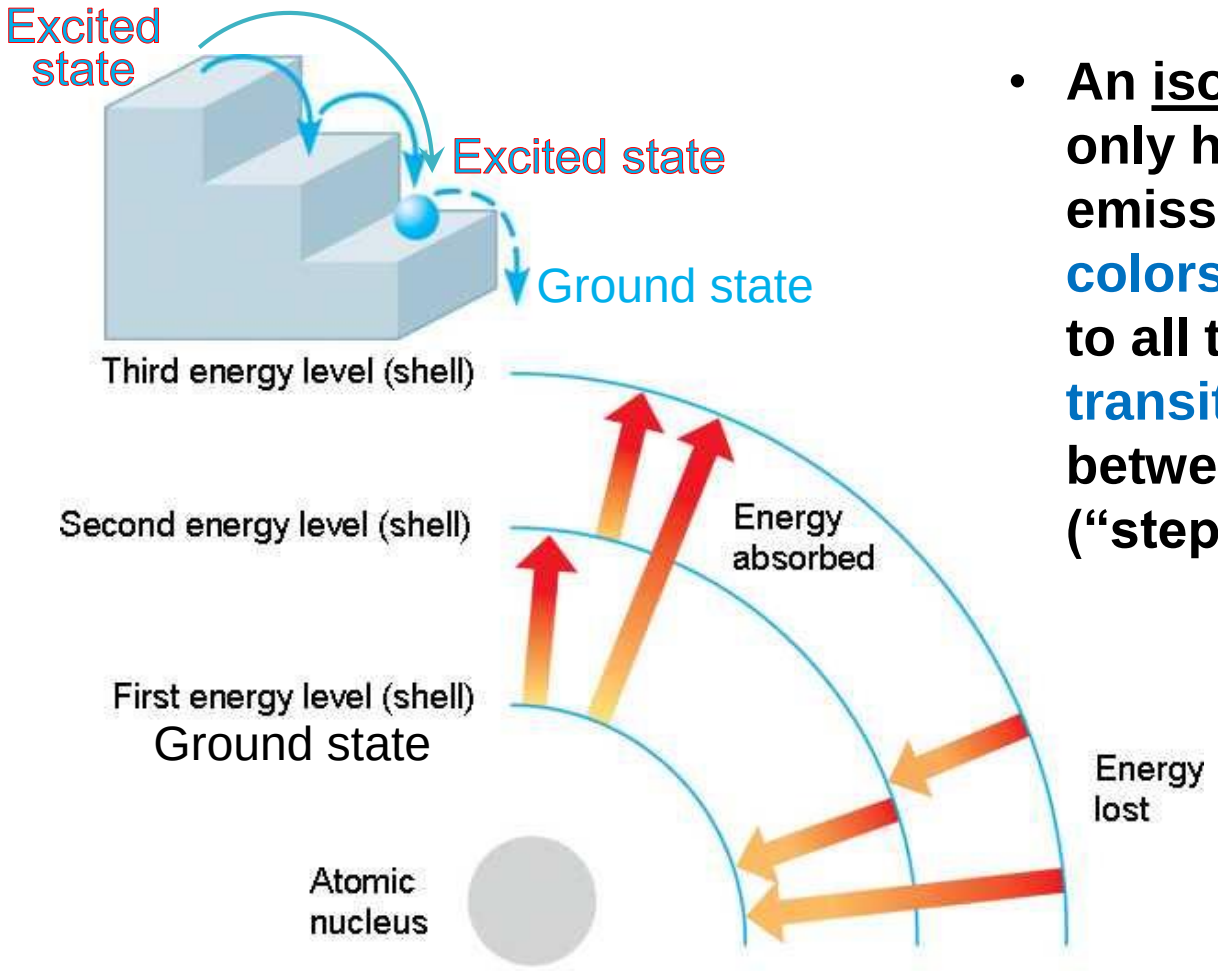
- **Electrons in atoms exist in one or more <u>energy levels</u> (*orbitals*) surrounding the nucleus.**
- **When the electrons are <u>excited</u>, for example by being heated, the additional energy pushes the electrons to <u>higher energy orbitals</u>.**
- **When the electrons fall back down and <u>leave the excited state</u>, energy is emitted in the form of a photon.**



# Electromagnetic Radiation

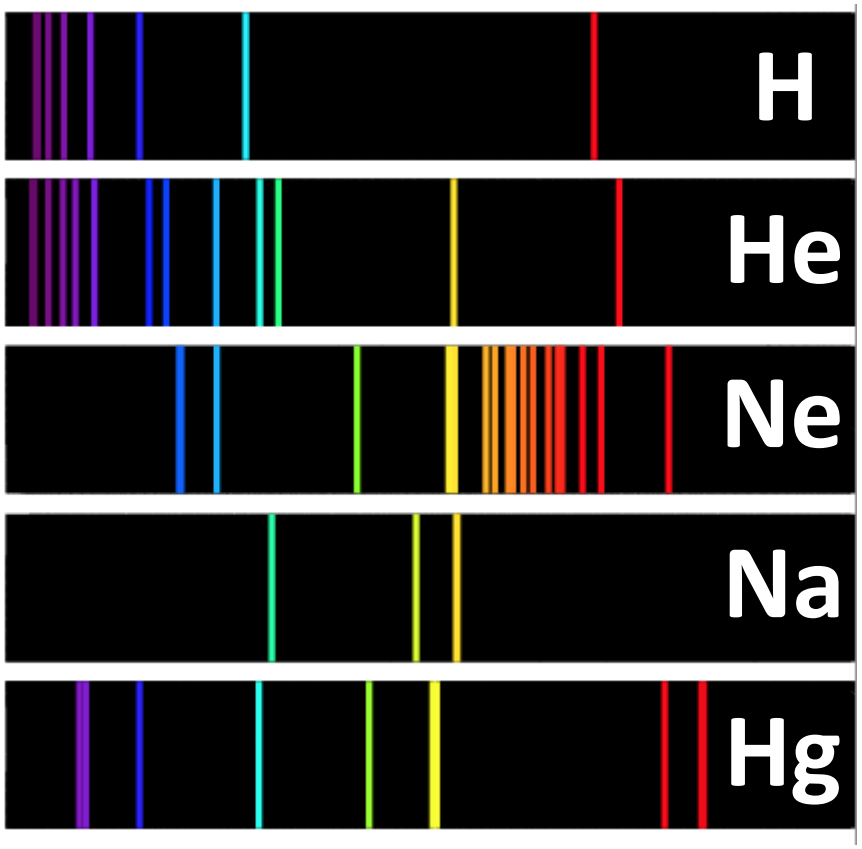
**A *ball bouncing down a flight of stairs* provides an analogy for energy levels of electrons in atoms: it can only rest on each step, not between steps; the lowest possible step is "ground".**




- **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 *evaporate* (get *isolated*)
- since they are *hot*, they ***emit light***