

EMR &

The Bohr Model of the Atom

→ one note

HISTORY

Democritus → atomos - indivisible

Dalton → Dalton's Atomic Theory → solid sphere model

Thomson → Plum Pudding Model → discovered electron (cathode ray tube)

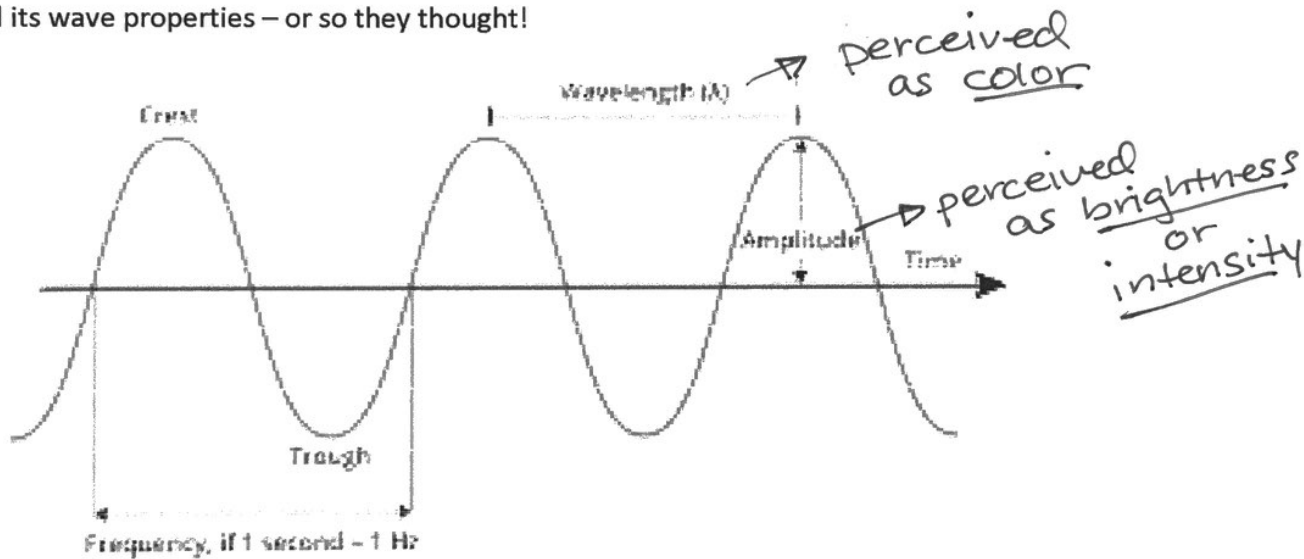
Rutherford → Nuclear Model → discovered the nucleus & most of an atom is empty space (gold foil experiment)

Meanwhile, in physics.....

Scientists were studying light and all of its properties. They were really studying

EMR electromagnetic radiation - which is any form of energy

that travels in a wave. They had learned everything about this energy and its wave properties - or so they thought!



Properties of waves:

Wavelength - λ (lambda) m/wave

Frequency - ν (nu) wave/s = Hz

Speed (velocity) - All electromagnetic radiation travels at the same speed in a vacuum. We call this speed **the speed of light (c)**. The speed of light is a constant in nature. It is 3.00×10^8 m/s.

Wavelength, frequency and energy of the waves are mathematically related:

$$c = \lambda \nu$$

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$$\frac{m}{s} = \frac{m}{wave} \times \frac{waves}{s}$$

λ and ν are inversely prop.

$$E = h \nu$$

↓
a constant

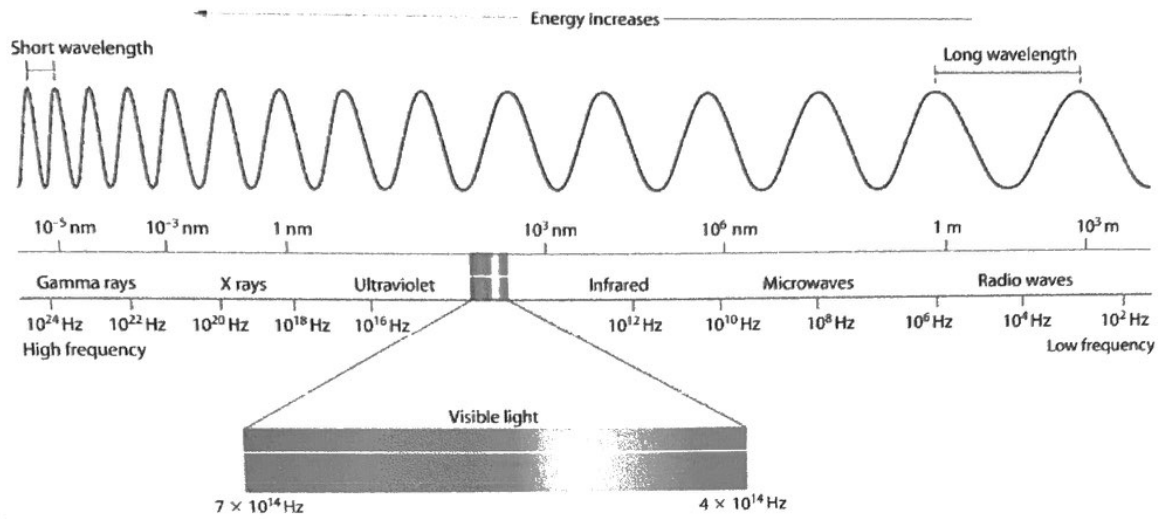
E and ν → directly prop.

$$\nu = \frac{c}{\lambda}$$

$$E = h \frac{c}{\lambda} = \frac{hc}{\lambda}$$

E and λ indirectly prop

Different types of Electromagnetic Radiation:



Radical Martians Invaded Venus Using X-ray Guns

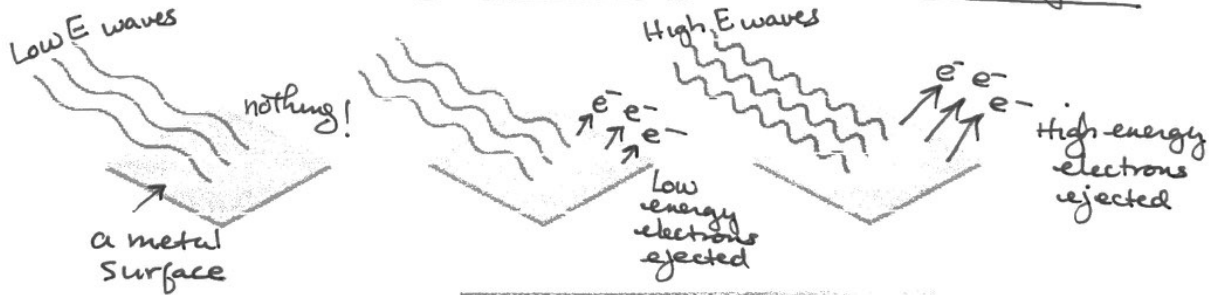
Radio Microwaves Infrared Visible Ultraviolet X-rays Gamma

R O Y G B I V

Low Energy -----> High Energy

Different Types of EMR

Then, along comes Einstein. He discovers a phenomenon called the **photoelectric effect**. He won a Nobel Prize for this discovery and it changed the way we think about electrons. Light!

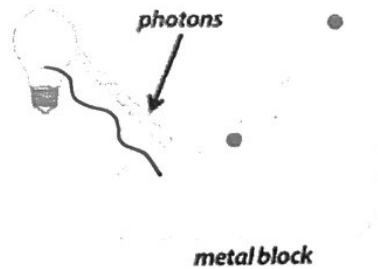


EVIDENCE FOR LIGHT AS A PARTICLE

A PHOTON CHECKS INTO A HOTEL AND IS ASKED IF HE NEEDS ANY HELP WITH HIS LUGGAGE.



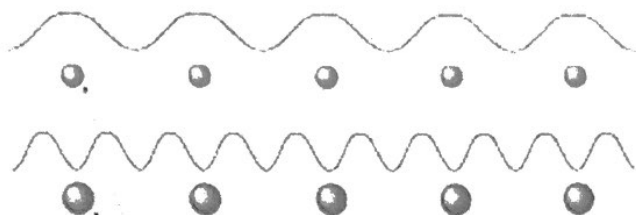
"NO, I'M TRAVELLING LIGHT."



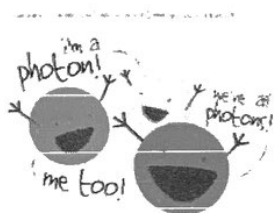
Source: FORD

Key

Red and Blue Light



Photons - particle of light that carries a quantum of energy



Einstein proved that waves of electromagnetic radiation had **particle properties**. One of these "particles" of light was called a

PHOTON

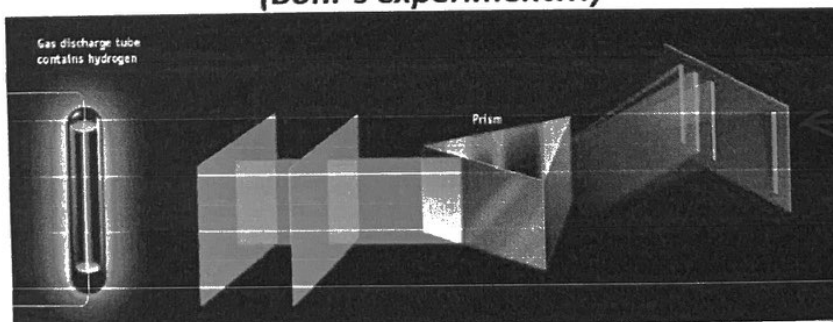
Each photon contains a **QUANTUM** of energy.

Dual Nature of Light
wave & "particle"
↓
photon

Now around this same time, chemists were trying to figure out how the electrons were arranged around the nucleus. A Danish scientist named Neils Bohr did an experiment with light and hydrogen gas and proposed that electrons were arranged around the nucleus in layers which he called **energy levels**. He determined that there are 7 of these layers of electrons.

Bohr's Experiment

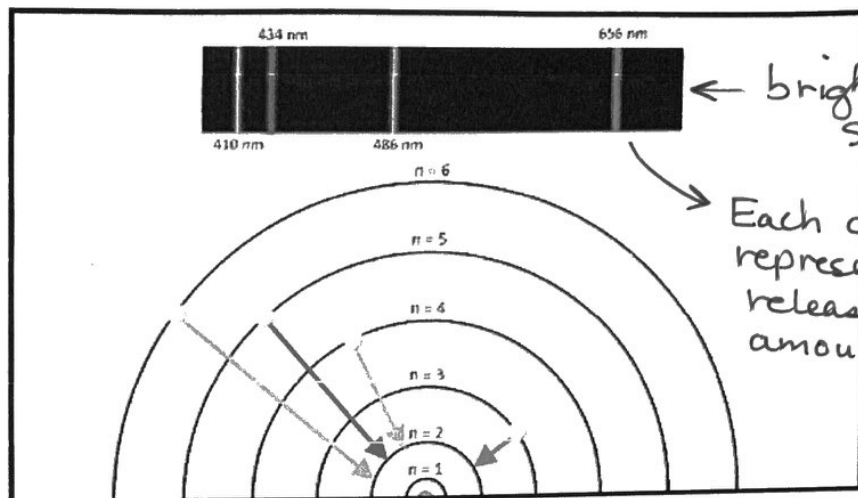
Emission Line Spectrum of Excited Hydrogen Gas (Bohr's experiment!!!)



- Light from a hydrogen discharge tube (**connected to power supply**) passed through a prism results in a series of narrow lines

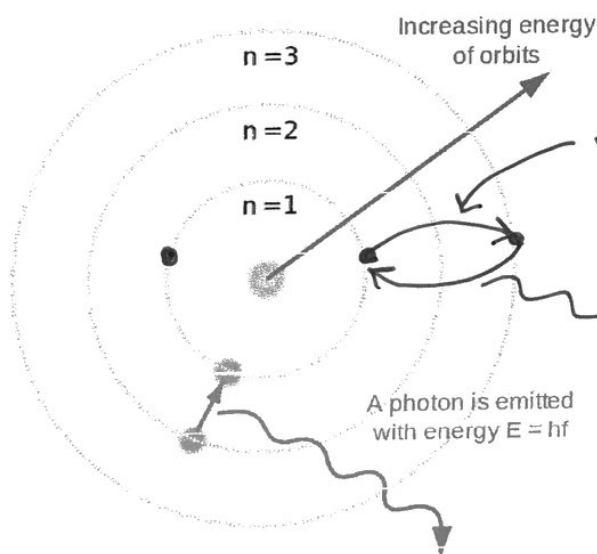
← bright line spectrum

rainbow → continuous spectrum



← bright line spectrum

Each colored line represents the release of a different amount of energy.



electron absorbs energy in the form of heat, light, or electricity
ground state → excited state

electron releases energy in the form of light
excited state → ground state

- Electrons absorb energy in the form of heat, light, or electricity. This causes the electron to jump farther away from the nucleus (to a higher energy level). When the electron is in this higher energy, we say that the electron is excited or in an excited state.
- Electrons will not remain in the excited state. They immediately lose the energy they absorbed and return to their original position closer to the nucleus and lower in energy. The low energy position is called the ground state.
- When the electrons release energy, it is always released in the form of LIGHT! We see this as different colors. The different colors are different wavelengths and different energies! This is what gave Bohr the idea that electrons existed in different energy levels. **They was NO EVIDENCE that electrons were ever in-between energy levels! This is the significance of the BRIGHT LINE SPECTRUM.**

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