

Wave – Particle Duality of Light

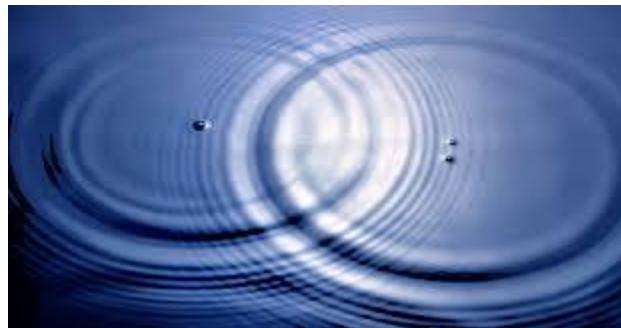
- **Light simultaneously has two different natures: WAVE and PARTICLE**
- **In some experiments: Wave nature is clearly seen , while in others particle nature is more clearly seen!!**



Consider waves on water:

<https://www.youtube.com/watch?v=SPXqMmvH7Pc>

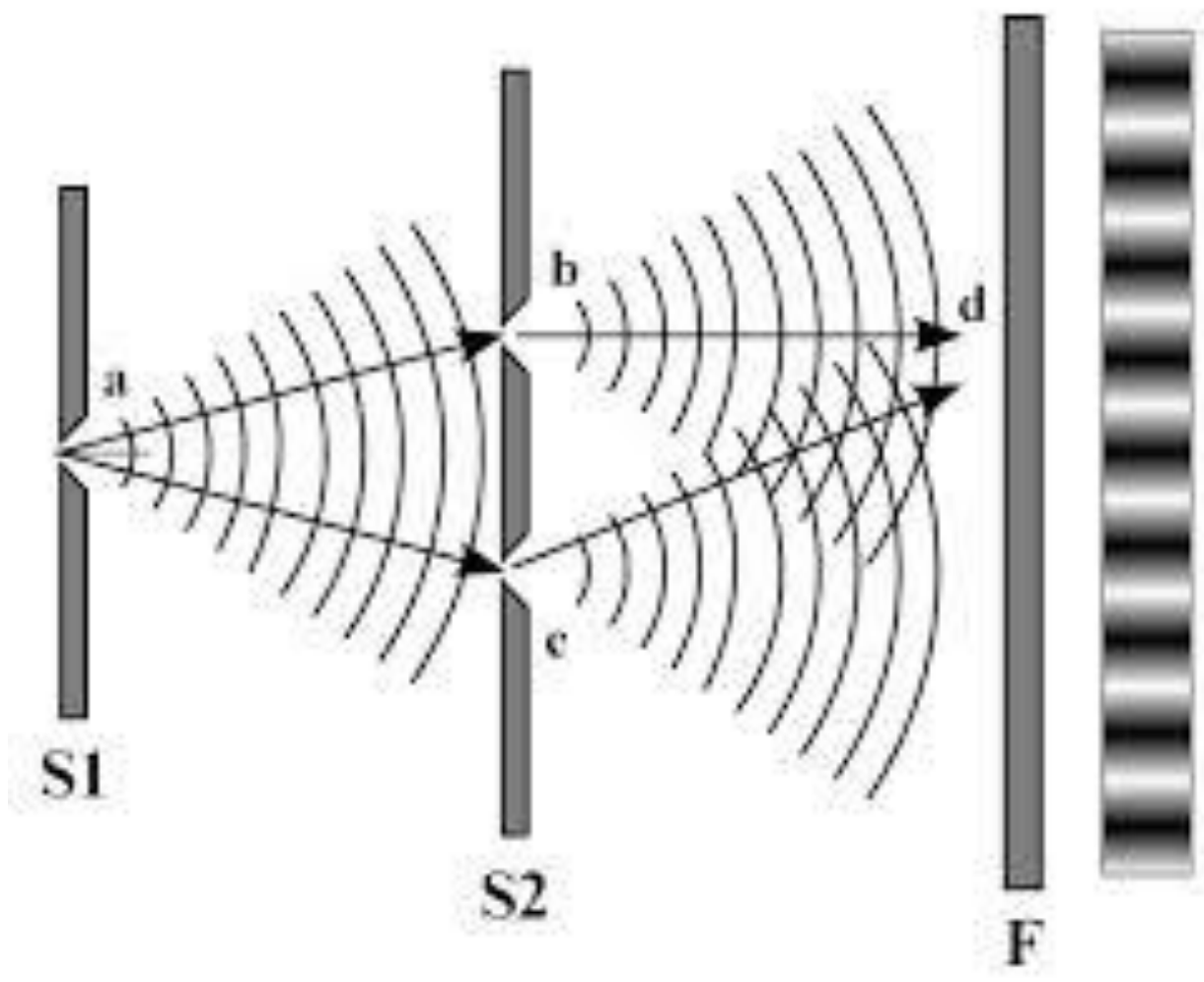
<https://www.youtube.com/watch?v=ovZkFMuxZNc>



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Double Slit Experiment

- 1801 English Physicist, Thomas Young passed a beam of light through a single slit and then through a double slit and observed the pattern on a darkened screen
- Observed INTERFERENCE, only occurs when two or more waves overlap = Light as WAVE



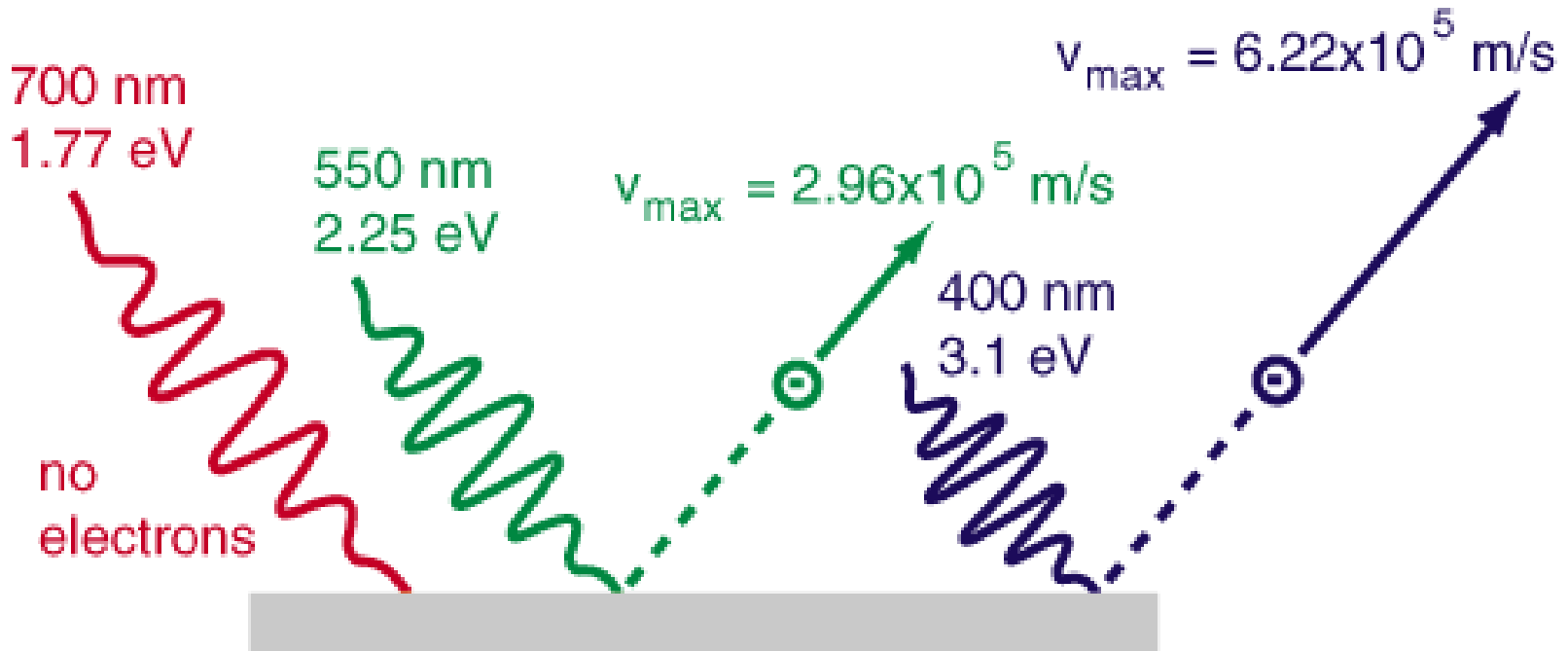


<http://www.youtube.com/watch?v=AgtKncAdlHQ>

Photoelectric Effect

- * Evidence of light as a particle
- * When light hits the surface of a metal, electrons are emitted
- * But, the light's frequency has to be above a certain minimum for it to cause the emission of electrons!
- * Blue Light emits electrons, red light does not
- * Discovered in 1887 by Heinrich Hertz

$$E_{\text{photon}} = h\nu$$




Potassium - 2.0 eV needed to eject electron

Photoelectric effect



1900: German physicist Max Planck was studying the emission of light by hot objects

Proposed that radiation is not emitted continuously (wave behavior) but in specific, discrete packets of energy = QUANTA



Planck mathematically showed
relationship between a quantum of
energy and the frequency of radiation

$$\triangle E = h\nu$$

E = Energy in Joules of a quantum of
radiation

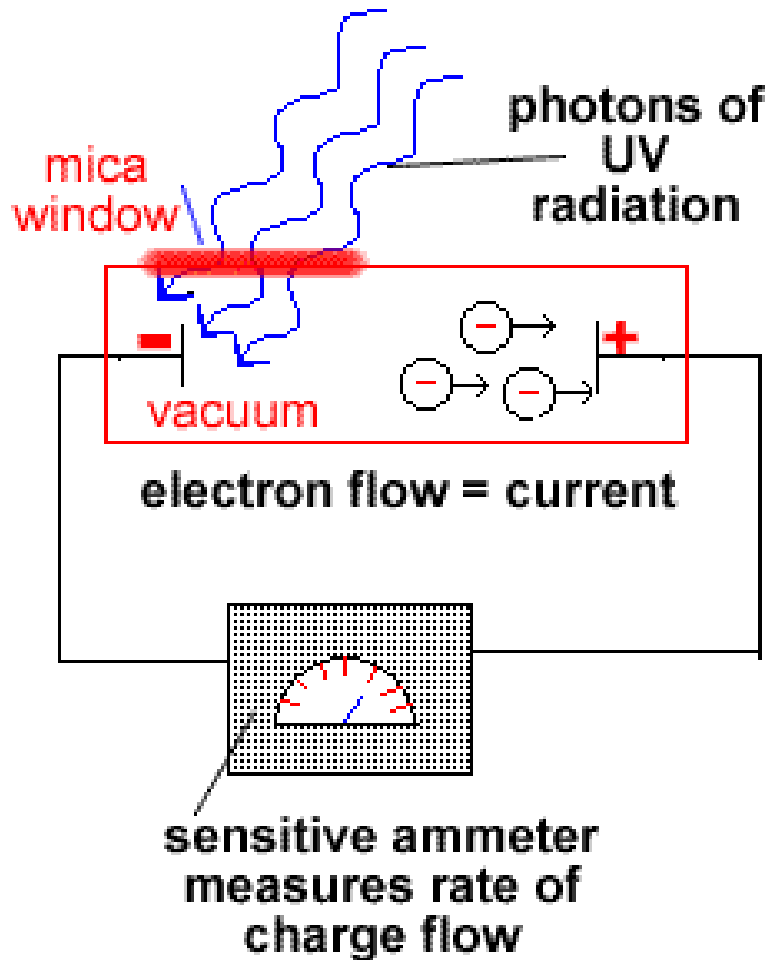
h = Planck's Constant = 6.626×10^{-34} J/s

ν = frequency

1905 : Photoelectric Effect Explained by Albert Einstein


- **Light as a stream of particles**
- **Each particle carries a quantum of energy**
- **Called particles Photons**
- **Explanation: in order for an e^- to be ejected from a metal surface, it must be struck by a photon which possess enough energy to knock it loose**

Photoelectric Effect





<http://www.youtube.com/watch?v=YQL2Q5ZArjs>



<http://www.youtube.com/watch?v=oqKrOF-gJZ4>