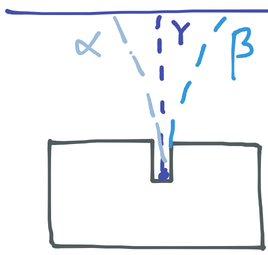
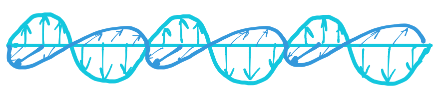
- Is nature discrete or not?

  discrete → particles
  continuum → fields

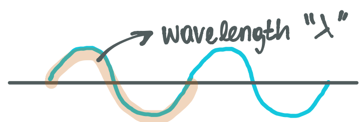


- under magnetic field, radiation beam splitted to 3 and deviated to different directions.
- the one that didn't deviate at all was electrically neutral, a PHOTON.
- β was ELECTRONS.
- α particles were Helium nuclei. 2 PROTONS + 2 NEUTRONS.

- EM radiation: radio waves, visible light, gamma rays



"light wave"



→ $\lambda = \omega L$

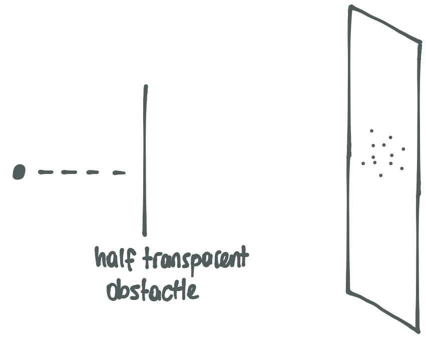
→ T : period

$\frac{\lambda \to \text{distance}}{T \to \text{time}}$ = for light = c
= for other waves its another v.

$\boxed{\lambda \cdot f = c}$

$w = 2\pi f$ (frequency in radians) → $f = c/\lambda$

$$\boxed{w = \frac{2\pi c}{\lambda}}$$



wave particle duality ← light is a wave / light is a particle

→ light is made of indivisable elements called PHOTONS

→ wave character of the light represents the probability that the photon appears at different places.

- when it comes to light, it's a manifestation of both particles & waves.

- if you do the double-slit experiment with 2 e^-s, you'll see that they exhibit wave behavior.

- $E = \hbar\omega$ → shorter wavelenght & higher frequency → MORE ENERGY

  longer wavelenght $\propto$ lower frequency → LESS ENERGY

- $E_{RAY} = n\hbar\omega$

  n → some integer → quantized

- $E = mc^2$ is only true for an object at rest. E → Rest Energy

- in particle physics rest mass → mass

  e^- and e^+ have the same mass.

  $\underset{-}{\bullet}$ $\underset{+}{\bullet}$ → at rest.

  → together $E = 2mc^2$

- for a particle at rest, mass & energy are the same thing.

  $E = mc^2$ is just an units conversion.

- $c = 2.99762498 \times 10^8$ m/s

- $\hbar = 1.054571628 \times 10^{-34}$ kg·m²/s

- particles are too light to experience any significant gravity.
- Momentum : objects at rest can have energy, but can't have momentum.

$$E = mc^2 \qquad m = E/c^2 \qquad p = m \cdot c = E/c$$

- $w = \frac{2\pi c}{\lambda} \qquad p = \frac{\hbar w}{c} = \frac{\hbar\, 2\pi \cancel{c}}{\lambda \cancel{c}} = \frac{\overbrace{2\pi\hbar}^{h}}{\lambda}$ → momentum of a photon

$p = h/\lambda$ → shorter wavelength – larger momentum
larger energy

- If you wanna detect small particles, you have to use shorter and shorter wavelengths, which requies larger energies, thus BIGGER machines!