

## Particle vs Wave Debate (classic underdog story!)

**PARTICLE** - Sir Isaac Newton (1642 – 1727) was in a very big debate towards the end of his life: is light a particle or a wave?

- Newton believed strongly that light was a **particle** (corpuscle theory). Published particle theory of light in 1704.
- Light travels in a straight line (shadows). Objects travel in a straight line. It travels straight through an opening and around a sharp edge (no diffraction – waves do that). Objects can reflect and light reflects.
- Light travels through a vacuum (space was believed to be a vacuum and yet sunlight reaches us). The only waves known at the time were mechanical waves (ie: water waves) and they needed a medium.
- Newton is very much respected by now and the President of the Royal Society so....his opinion carried a lot of weight.

**WAVE** - others strongly believed light was a wave. People like Dutch physicist Christian Huygens (1629 – 1695).

- Most scientists believed Newton (because he was Newton).
- Huygens decided to prove that light diffracts (and thus cannot be a particle) He used the observations of Francesco Grimaldi who had shown the edges of a shadow are not crisp and sharp. They are fuzzy as if light is diffracting around the edge.
- Huygen said we should think of waves as being made up of an infinite number of tiny waves or wavelets. As the wave goes through a small opening or around a crisp edge, these wavelets spread out and thus diffract. “Wavelet theory”

Time Passes....

- About 100 years later, a British scientist, Thomas Young (1773 – 1829) performed the ‘double slit experiment’ in which he showed light diffracting AND the resulting interference pattern. This is now known as the ultimate experiment for showing light’s wave nature.
- Still....the science community backed Newton’s particle theory (because he was Newton). He was long dead by now but that didn’t seem to matter.
- Then in 1819, the French Academy sponsors a contest to help determine the nature of light. Augustin-Jean Fresnel (1788 – 1827) presented light diffraction results to support wave theory.

A Challenge!

- One of the contest judges, Simeon-Denis Poisson, was a particle guy and challenged Fresnel. Challenge: if light diffracts, then if you shine a light at the centre of a round object, you should see a bright spot in the centre of its shadow (since the light diffracts

around). Poisson was really making fun of Fresnel because everyone knows there isn't a light spot in the middle of a shadow!

- Francois Arago believed in Fresnel and performed the experiment. (it is rather precise) .....and..... yes, he observed this central bright spot!
- As a joke on Poisson, this central white spot has become known as the 'Poisson spot'!

So...it seems, light IS a wave. Waves can

- Travel in a straight line (rectilinear propagation)
- Reflect
- Refract (when entering a new medium)
- Diffract (through small openings and around sharp corners)
- Create interference patterns