Quantum Explainers 03

WAVE BEHAVIOUR

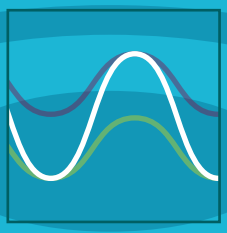
INTERFERENCE

Interference is what happens when waves mix together, like waves in water.

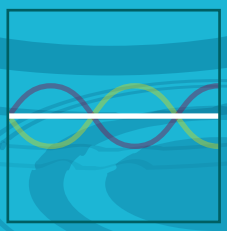
If the peaks of two waves mix, this will make a really big wave. This is called **'constructive'** interference. If the peak of one wave hits the dip of another wave, this will cancel out both waves. This is called **'destructive'** interference.

In quantum systems, it's not just waves that can interfere, particles do it too!

Constructive interference
When the peaks line up, they form a bigger wave.



Destructive interference
When peaks line up with dips, they cancel each other.



DOUBLE SLIT EXPERIMENT

If you throw tennis balls at a screen with two holes in it, the balls will go through one or the other of the holes and predictably end up in two piles on the other side of the holes.

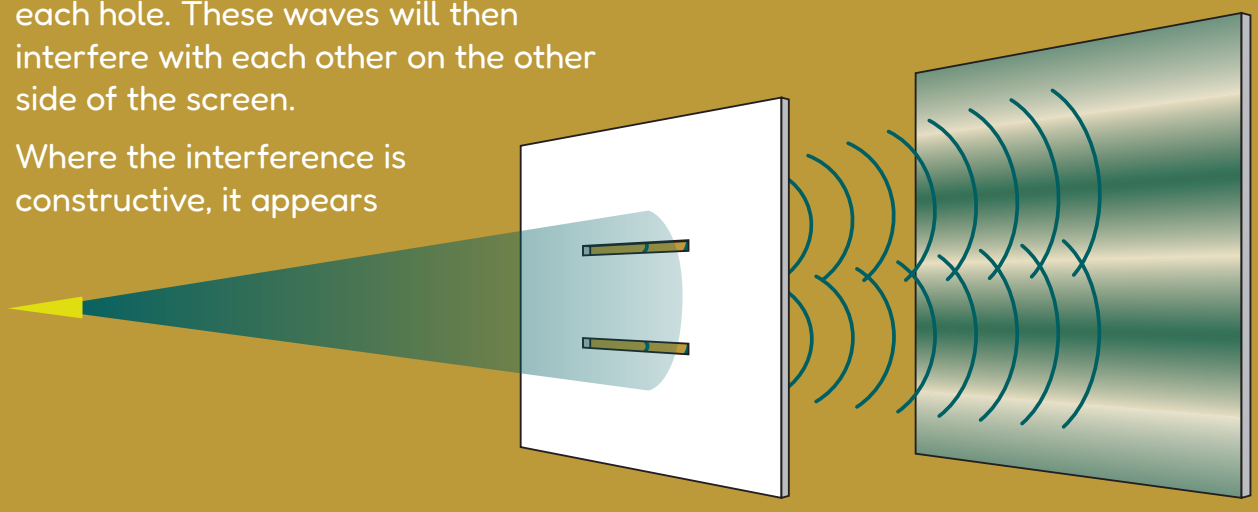
Waves behave very differently. A wave that hits the same screen (e.g. a sound wave) will go through both holes at once and waves will spread out from each hole. These waves will then interfere with each other on the other side of the screen.

Where the interference is constructive, it appears as bright bands of light. Where it is destructive, the bands are dark. This experiment shows that light is a wave.

Quantum particles do something strange when they go through the screen.

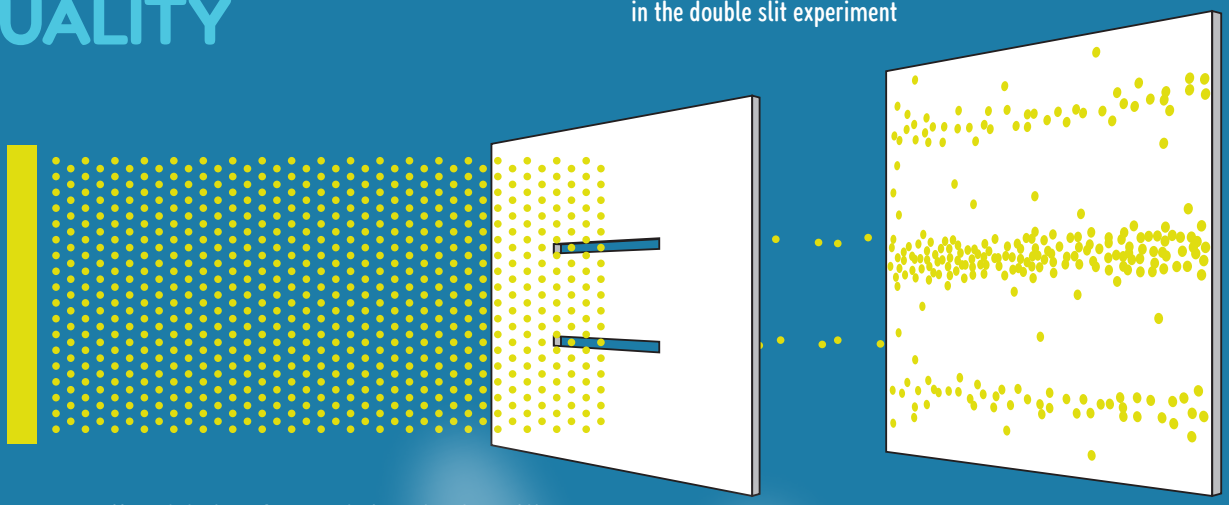
Things like photons, electrons or even atoms.

The particles arrive at the other side of the screen as a whole object, but they still land in a ripple pattern. They have behaved as both a wave and a particle at the same time!



WAVEPARTICLE DUALITY

Particles show the same kind of distribution as waves in the double slit experiment



We normally think of particles being like balls, and waves being like water waves - very different things!

But at the tiny quantum scale, it turns out that waves and particles behave in very similar ways.

Things we think of as waves, such as light and sound, actually come in little particle-like packets of energy called 'quanta'.

'Quanta' is just the plural of 'quantum'

Things we think of as particles, such as electrons, can interfere with each other (think of waves on water mixing together), and so have a definite wave-like character.

This is something that quantum physics calls 'waveparticle duality'.

Duality means being two things at once.

PLANCK'S CONSTANT, *h*

We mean unbelievably tiny.

This is a very small number, named after Max Planck and represented by *h*. It tells us how much energy the tiniest piece of light (a photon) can carry.

Max Planck was a German who made a lot of the discoveries that led to our early understanding of quantum physics. He won the Nobel Prize for Physics in 1918.

The longer the light's wavelength (that is, the redder it is), the lower its energy.

Lower energy — Higher energy

You'd need the energy of 7,500,000,000,000,000,000 **(7.5 quintillion)** red photons just to heat a teaspoon of water by one degree. Amazingly, our eyes are so sensitive that they can detect a single photon!

Planck's constant is used to work out the energy of a **photon**.

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