

Related Quantum Mechanics concepts

(simplified) (basic concepts)

Wave-particle duality

(波粒二象性)



$$\lambda = \frac{h}{p}$$

de Broglie's matter wavelength formula

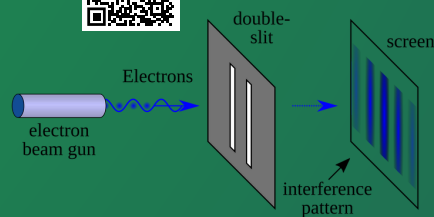
Hydrogen atom (or H⁺/H⁻) and Electrons

(or any matter)

can have the behaviours of both a

particle and a **wave**

(refer to the **double-slit experiment**)



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Don't know interference?
Ask a nearby physics teacher.
(Wave Motion II 3B and
Atomic World E2 related)

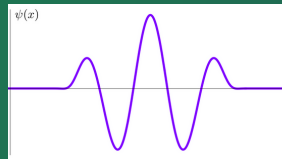
Wave function

(波函数)

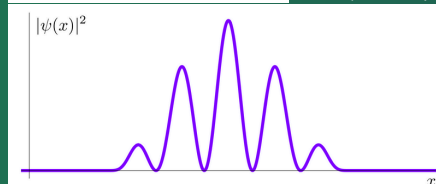


It provides the **probability** for finding a **particle** in a particular position (or state).

Below are two graphs demonstrating a single wave function



In the first graph, there are negative values. However, it does not mean low probability. Instead, the squared wave function (second graph) gives the probability density.



This is only possible because the **particle** is **not measured**. It exists in **superposition**(疊加態). After measuring, the **wave function collapses**.
The particle exists in a **definite state**.

Quantum entanglement

(量子纏結)

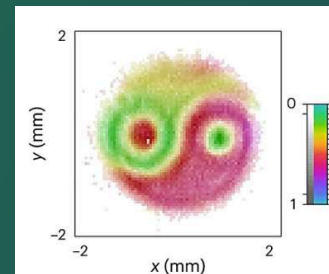


"spooky action at a distance"

-Albert Einstein

A phenomenon where **two particles** become **linked**, so that **the state of one particle instantly influences the state of the other, no matter how far apart they are**.

When **particles** are **entangled**, their **wave functions cannot be described independently**; they must be considered as **a single system**.

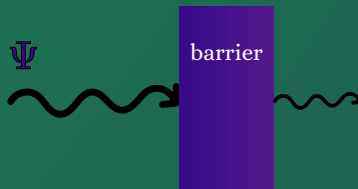


Visualisation of two entangled photos (yin-yang pattern).[5]

Quantum tunneling

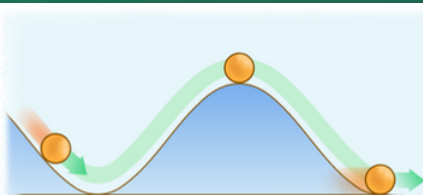
(量子穿隧效應)

A consequence of **Wave-particle duality** and **Wave function**

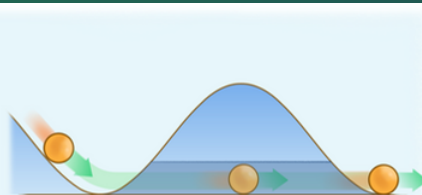


A phenomenon where **particles can pass through** a **barrier** that they normally wouldn't be able to cross

Below are two diagrams. One simplifies quantum tunneling, while the other is more detailed

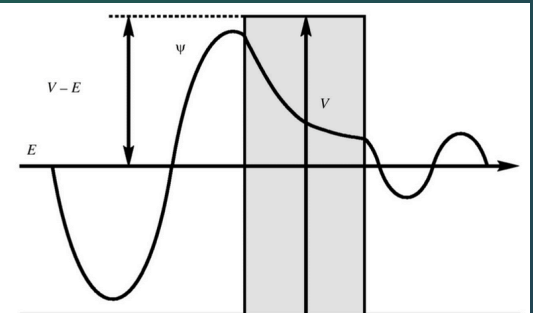


In Classical Mechanics, electrons must climb the potential hill to appear on the other side.



Quantum Mechanics allows electron with less energy to tunnel thru the barrier and appear on the other side.

Consider a **particle with energy E** that is confined in a box which has a **barrier of height V**. Classically, the box will **prevent these particles from escaping** due to the **insufficiency in kinetic energy** of these particles to get over the barrier. However, if the **thickness of the barrier is thin**, the particles **have some probability** of penetrating through the barrier **without sufficient energy** and appear on the other side of the box



There is still some probability behind the barrier, but it is diminished