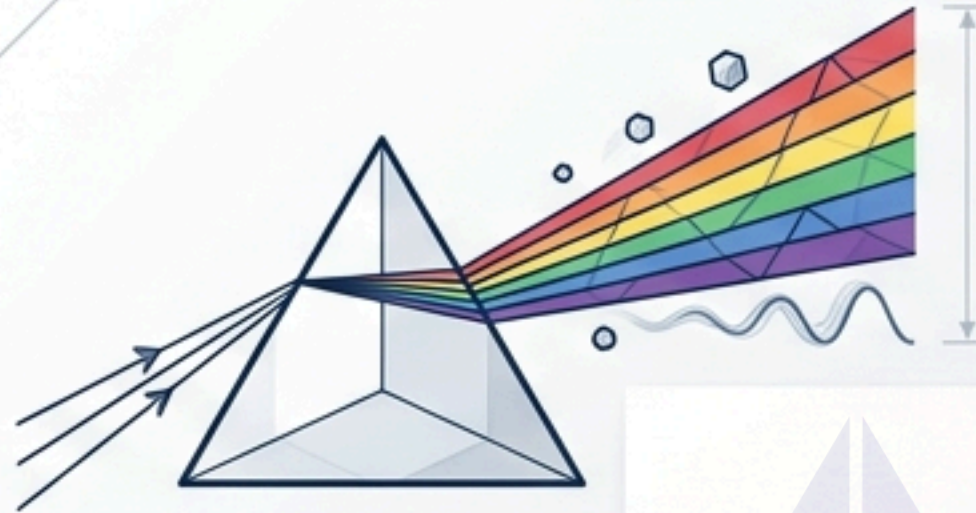


Dual Behaviour of Matter



The Paradigm Shift: From Classical Mechanics to Quantum Reality.

Based on the 1924 proposition
by Louis de Broglie.



Known:
Dual Nature
(Photons + Waves)

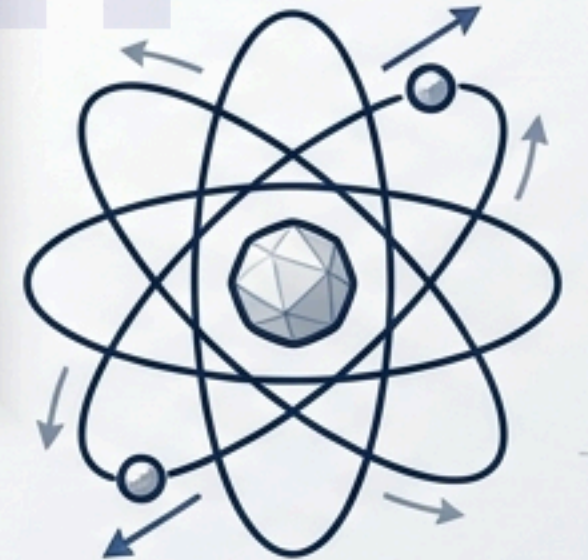
The Core Proposition



In 1924, Louis de Broglie proposed that matter, just like radiation, exhibits both particle and wavelike properties. Electrons possess both momentum and wavelength.



Classical View:
Particle Only
(Momentum)



λ (Wavelength)
SI Unit: meters (m)

$$\lambda = h / mv = h / p$$

h (Planck's Constant)
 $6.626 \times 10^{-34} \text{ J s}$
Note: $1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2}$

$p = mv$ (Momentum)
m: mass (kg)
v: velocity (m/s)



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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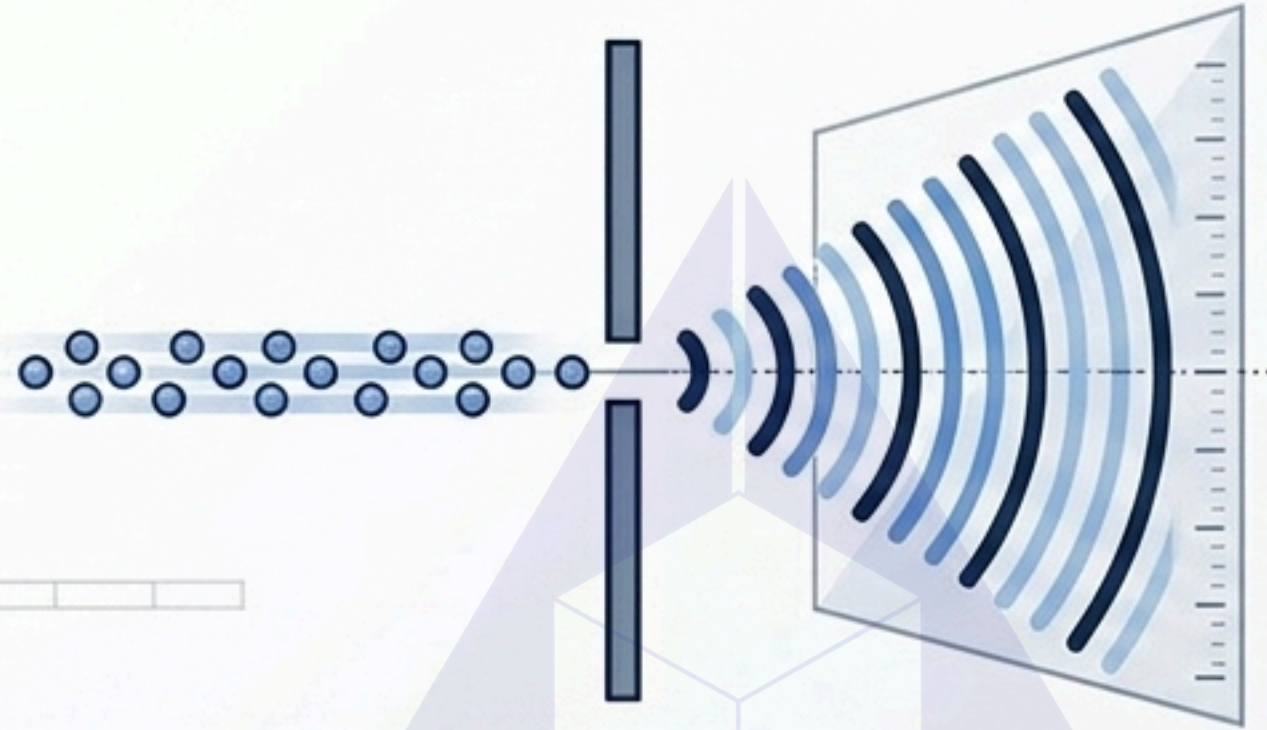
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Key Highlights

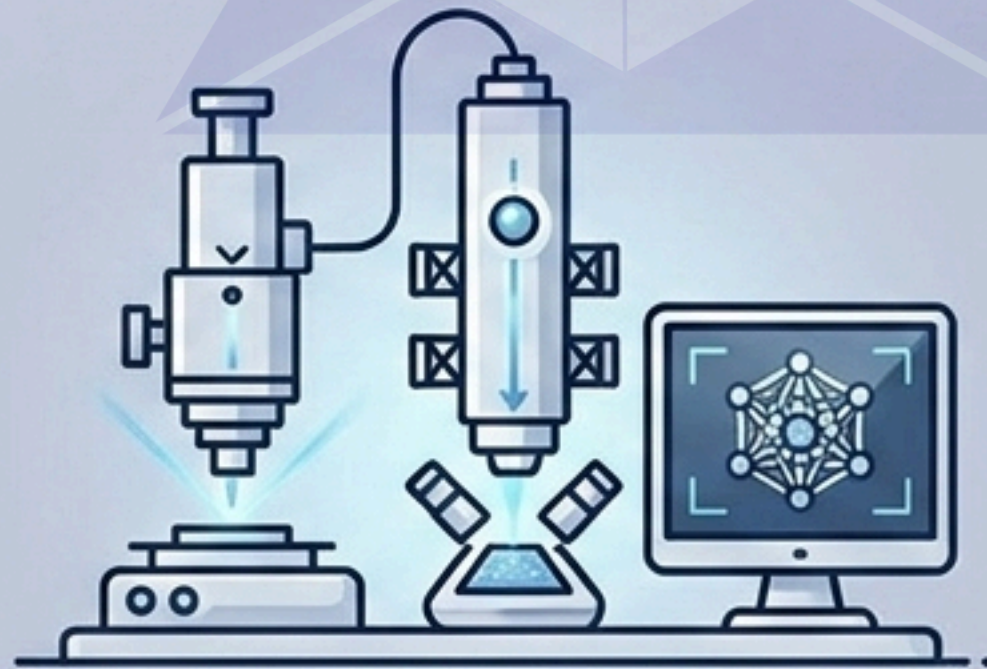
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The Evidence: Electron Diffraction



De Broglie's prediction was experimentally confirmed when an electron beam was shown to undergo **diffraction**—a phenomenon strictly characteristic of waves.



Application: The Electron Microscope.

Utilizing the wave nature of electrons to achieve magnifications of ~15 million times.

Macro vs. Micro: Why Wavelength Matters



The Macro World

0.1 kg Ball at 10 m/s

$$\lambda = \frac{6.626 \times 10^{-34}}{(0.1 \times 10)}$$

$$\lambda = 6.626 \times 10^{-34} \text{ m}$$

Undetectably small.
Wave properties are
irrelevant.



The Micro World

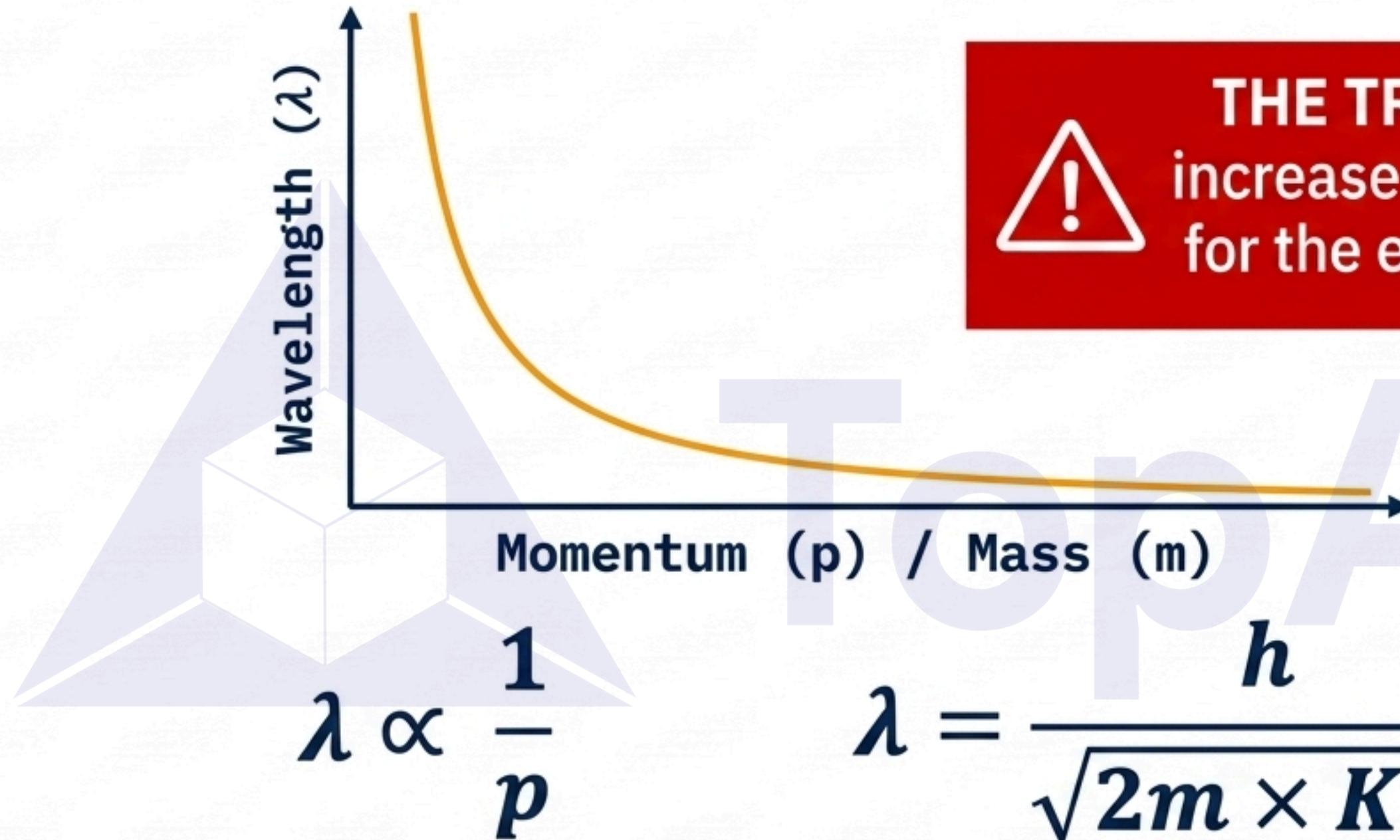
Electron (9.1×10^{-31} kg)

$$v = 812 \text{ m/s}$$

$$\lambda = 896.7 \text{ nm}$$

Physically measurable.
Wave properties define
its behavior.

Exam Caution: The Proportionality Trap



THE TRAP: Examiners will increase mass or K.E. and ask for the effect on wavelength.

$$\lambda = \frac{h}{\sqrt{2m \times K.E.}}$$

As **Momentum** (p), **Mass** (m), or **Kinetic Energy** (K.E.) scales **UP**, the de Broglie Wavelength (λ) scales **DOWN**.

Key Takeaways



Universal Duality

Every object in motion possesses a matter wave, merging particle and wave theories.



The Governing Equation

$\lambda = h/mv$ Unifies macroscopic concepts (mass, velocity) with the quantum realm (Planck's constant).



The Microscopic Limit

Due to the incredibly small value of 'h', wave character is only physically significant for subatomic particles like electrons.



You've Learned the Theory.

Now Let's Test It.

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