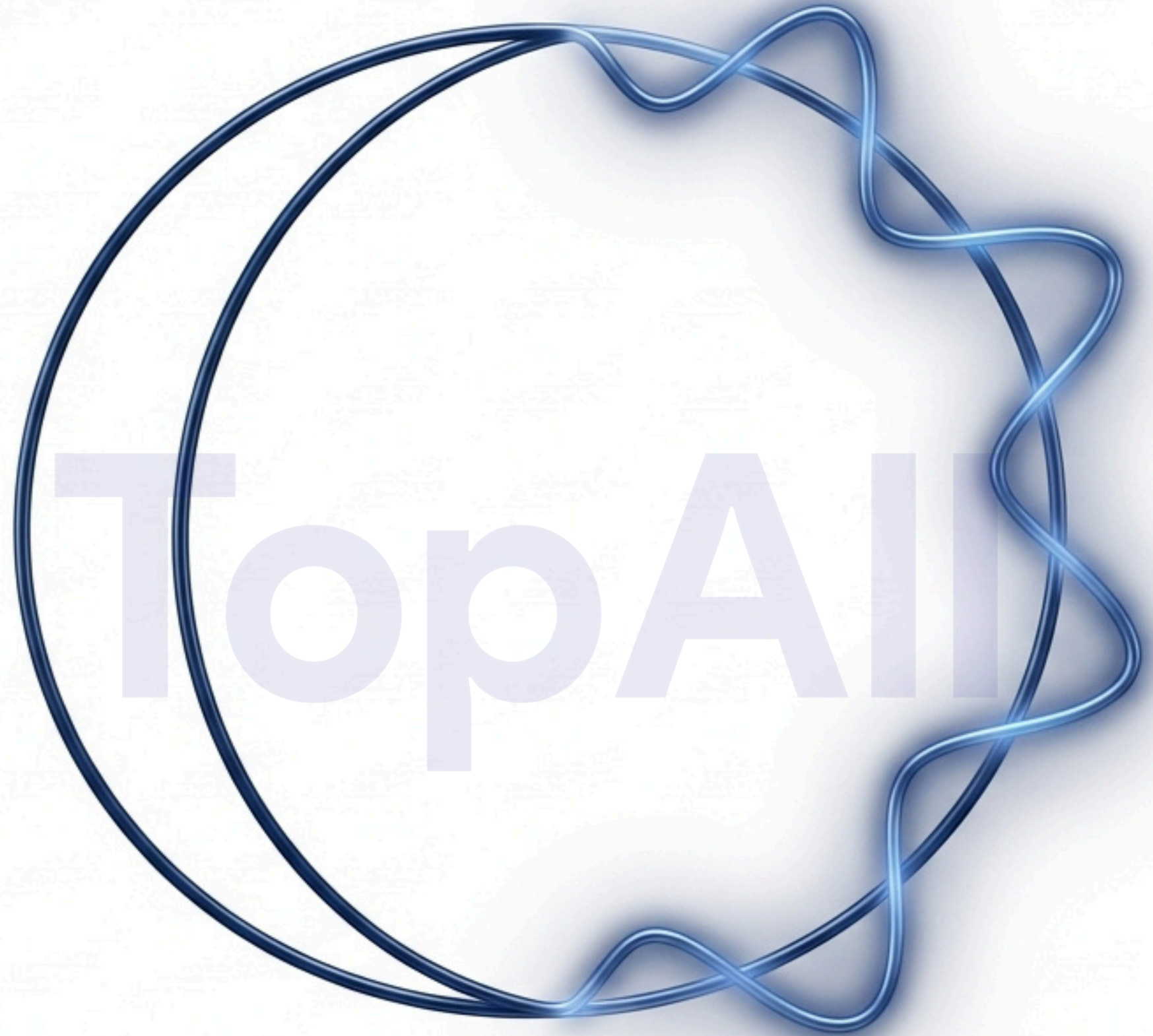
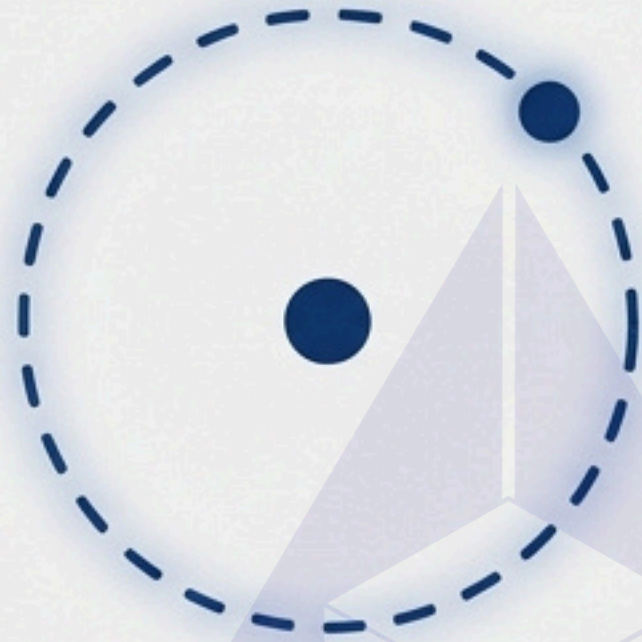


de Broglie's Explanation of Quantised Orbits

Why only certain electron
orbits survive



H2: The Missing 'Why?' in Bohr's Model



Bohr's Second Postulate:

$$L = \frac{nh}{2\pi}$$

(where $n = 1, 2, 3...$)

Unsolved Physics

Bohr's rule worked perfectly to predict hydrogen spectra, but it was an arbitrary assumption. He could not explain why angular momentum had to be an **integral multiple of $h/2\pi$** .

Why didn't intermediate orbits exist?

H2 Title: The Clue: Matter Waves

1923: Louis de Broglie proposes a radical idea.

Particle



Momentum:

$$p = mv$$

Wave



Wavelength:

λ

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

Electrons in circular orbits must be seen as particle waves, not just tiny planets.



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

$$E=mc^2$$



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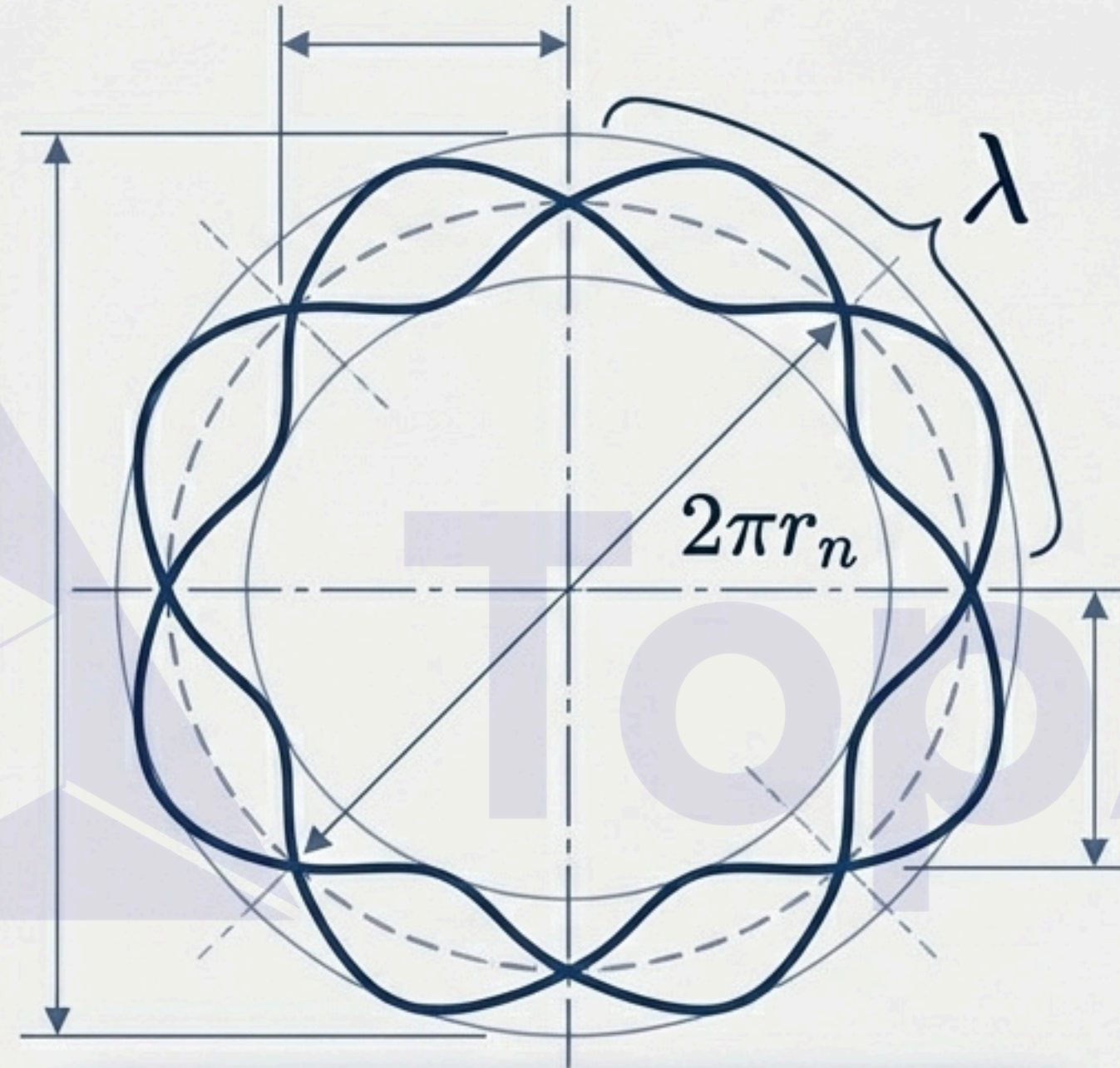
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Key Highlights

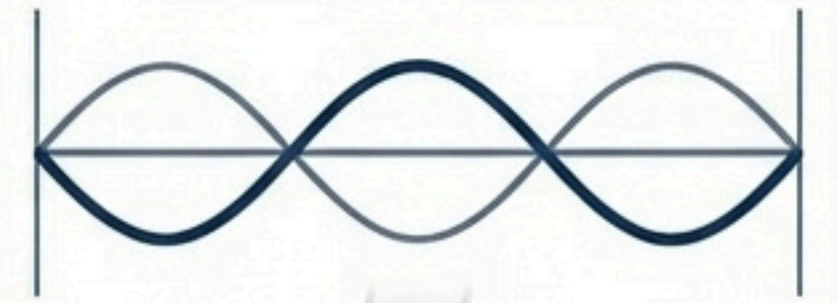
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H2 Title: The Orbit as a Standing Wave



String Analogy



The Standing Wave Condition:

$$2\pi r_n = n\lambda$$

H2 Title: Allowed vs. Not Allowed Orbits

Exact Wave Fit (Resonance)



Condition: $2\pi r = n\lambda$

Behavior: Constructive interference.
Nodes align perfectly.

Result: Electron survives.
Stable orbit.

Destructive Mismatch



Condition: $2\pi r \neq n\lambda$

Behavior: Destructive interference.
Waves cancel each other out.

Result: Orbit collapses.
Electron cannot exist here.

H2 Title: The Equation Bridge: Proving Bohr Right



Start with the standing wave condition.

$$2\pi r_n = n\lambda$$

Substitute de Broglie's wavelength ($\lambda = h/mv_n$).

$$2\pi r_n = n\left(\frac{h}{mv_n}\right)$$

Rearrange the terms.

$$mv_n r_n = \frac{nh}{2\pi}$$

Bohr's Quantisation Condition ($L = \frac{nh}{2\pi}$)

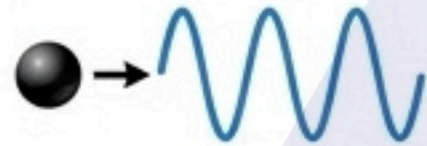
De Broglie mathematically proved that Bohr's arbitrary rule is simply the natural behavior of a resonant wave!

H2 Title: **The Quantum Paradigm Shift**



Orbits are not tracks.

Classical physics imagined electron orbits like train tracks in space. Quantum physics reveals they are resonant wave states.



Wave-Particle Duality is real.

The quantised energy states of atoms exist precisely because the electron is behaving as a wave that must perfectly close in on itself.



The Limits of Bohr.

While brilliant for Hydrogen, Bohr's planet-like model fails for multi-electron atoms (like Helium) because it ignores electron-electron forces. This wave insight paved the way for modern Quantum Mechanics.

H2 Title: **Recap & Check Your Understanding**

Key Takeaways

- ✓ 1. Bohr's 2nd Postulate ($L = nh/2\pi$) was an unexplained assumption.
- ✓ 2. De Broglie solved it using matter waves ($\lambda = h/mv$).
- ✓ 3. Stable orbits require a standing wave: $2\pi r = n\lambda$.

Self-Check

Q1: If an electron is in the $n = 3$ orbit of hydrogen, how many full de Broglie wavelengths fit perfectly around its circumference?

Answer: 3

Q2: Why do orbits where $2\pi r = 4.5\lambda$ not exist in an atom?

Answer:

Destructive interference causes the wave to quickly drop to zero.



You've Learned the Theory.

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