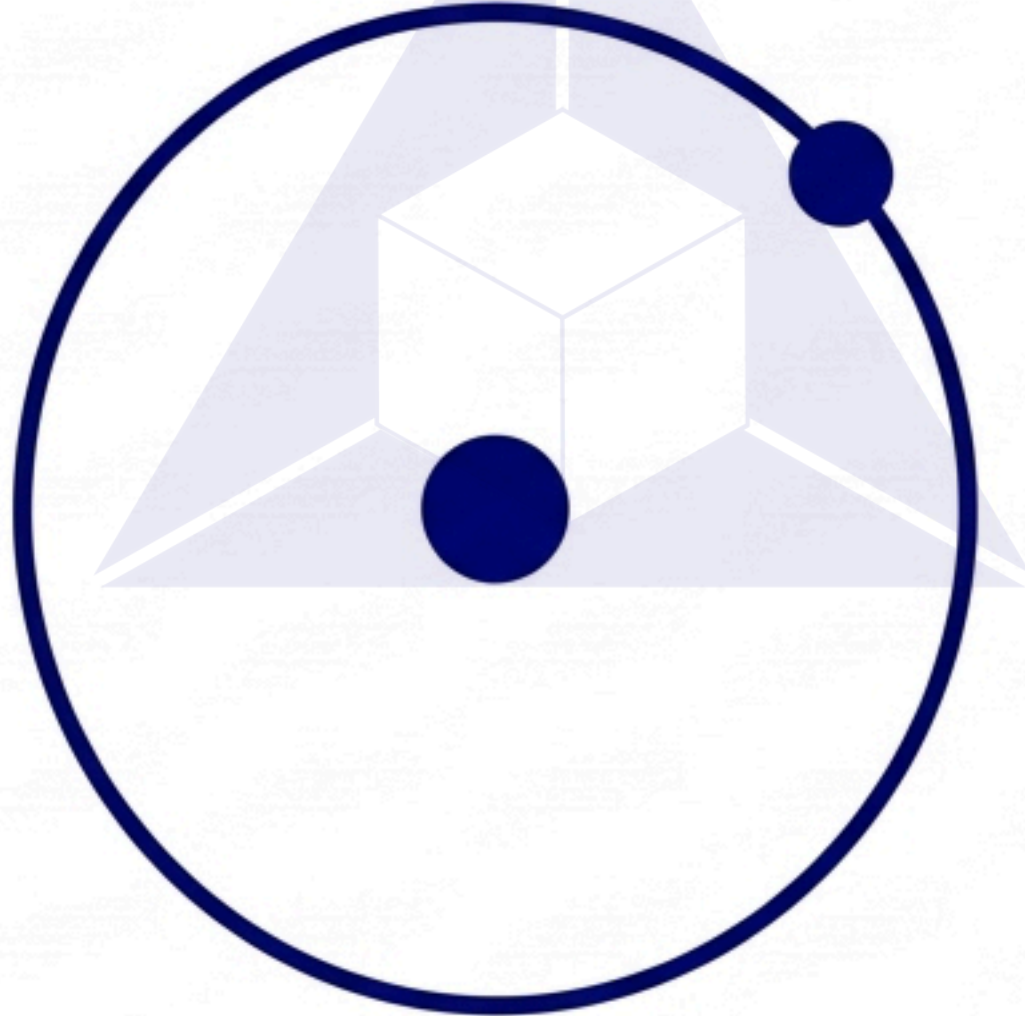
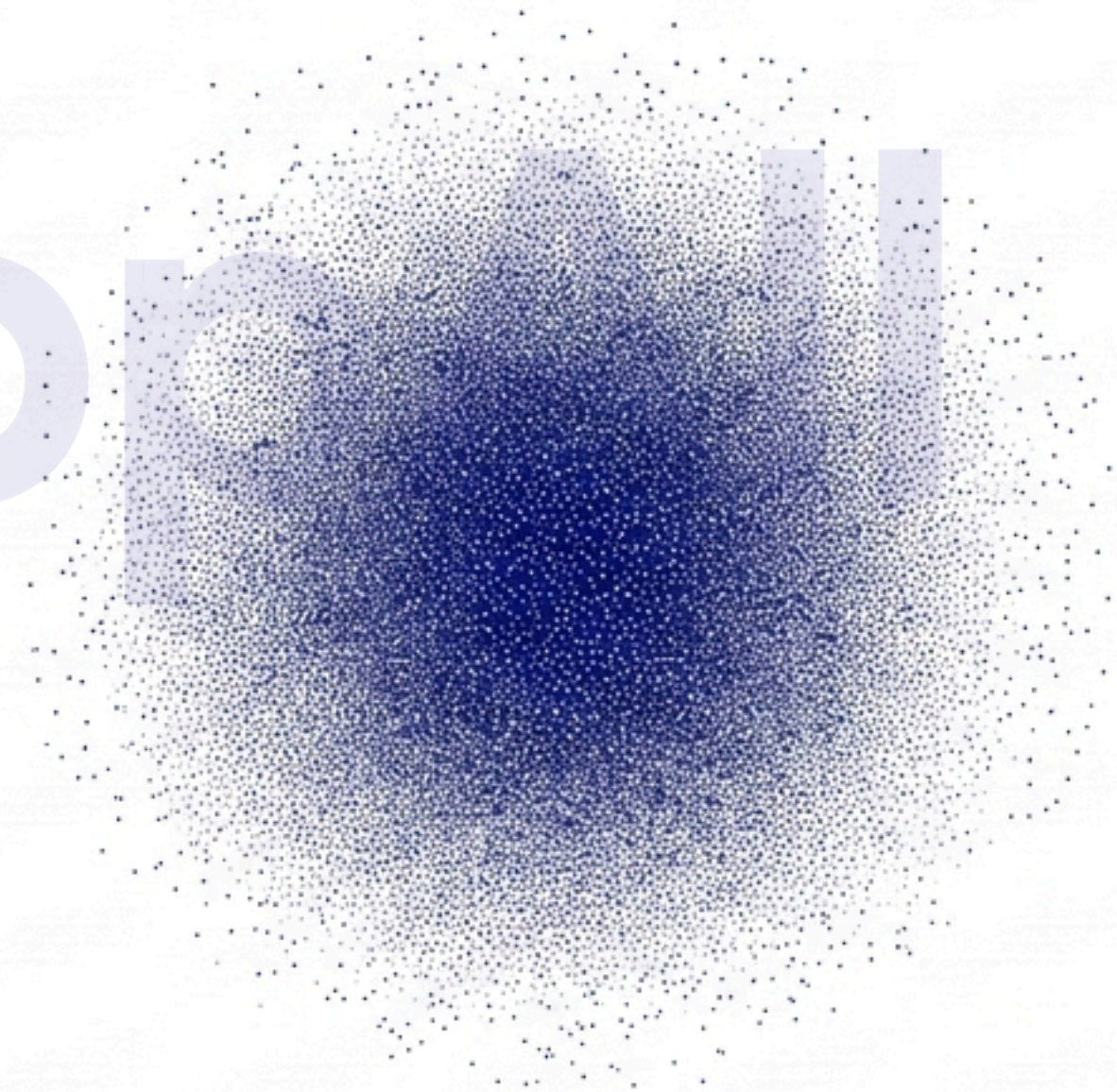


2.4.2 Limitations of Bohr's Model

THE BLUEPRINT



THE REALITY



Why Fixed Circular Orbits Became Problematic

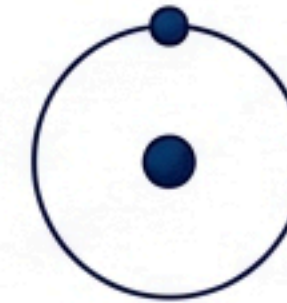
Fine Spectra (Doublets)



$\Delta\lambda \sim 0.016 \text{ nm}$
H α doublet

Fails to explain the finer details (doublets) of the hydrogen spectrum observed with high-resolution spectroscopy.

Multi-Electron Atoms



H ($1e^-$)

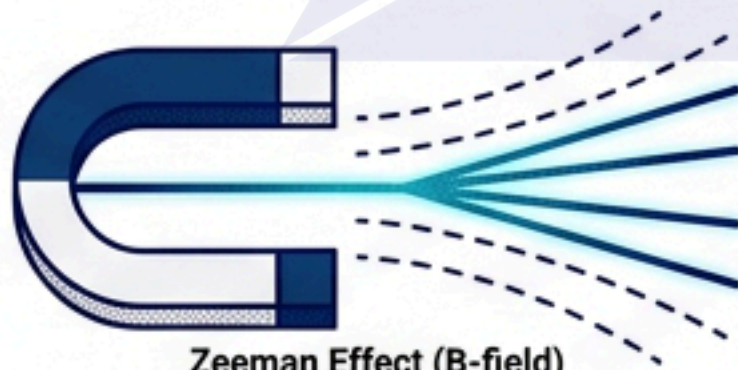


He ($2e^-$)

Only works for H and H-like single-electron ions.
Completely breaks down for atoms with two or

He $\approx$ H + e^- + e^- Li $^{2+}$, Be $^{3+}$

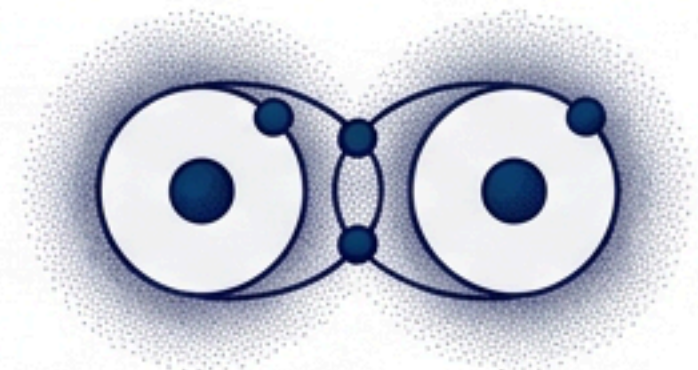
Field Splitting



Zeeman Effect (B-field)
Stark Effect (E-field)

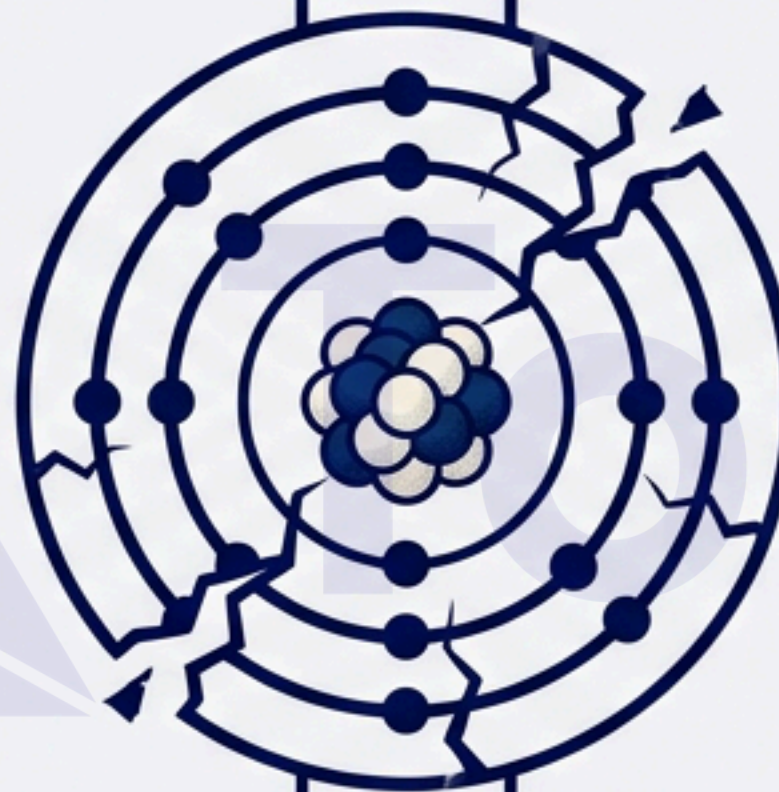
Cannot explain the splitting of spectral lines under magnetic fields (Zeeman effect) or electric fields (Stark effect). $\Delta E \sim E$

Chemical Bonding



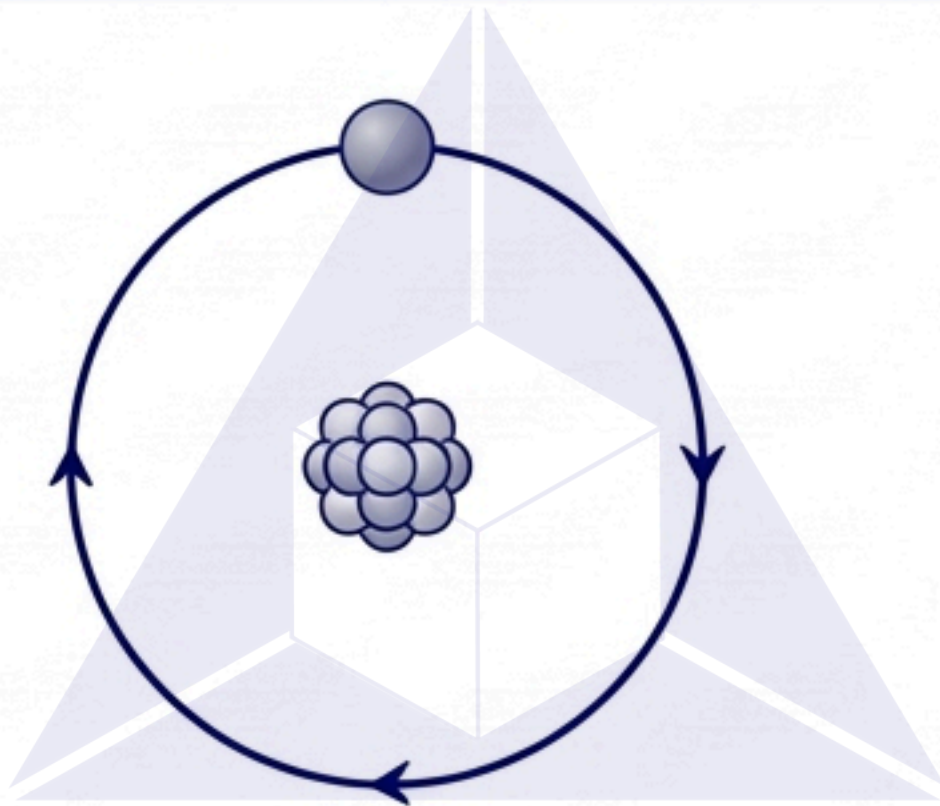
Provides no mechanism to explain the ability of atoms to form molecules via chemical bonds.

H + H $\rightarrow$ H $_2$ Ψ_{molecule}



Conflict with the Wave Nature of the Electron

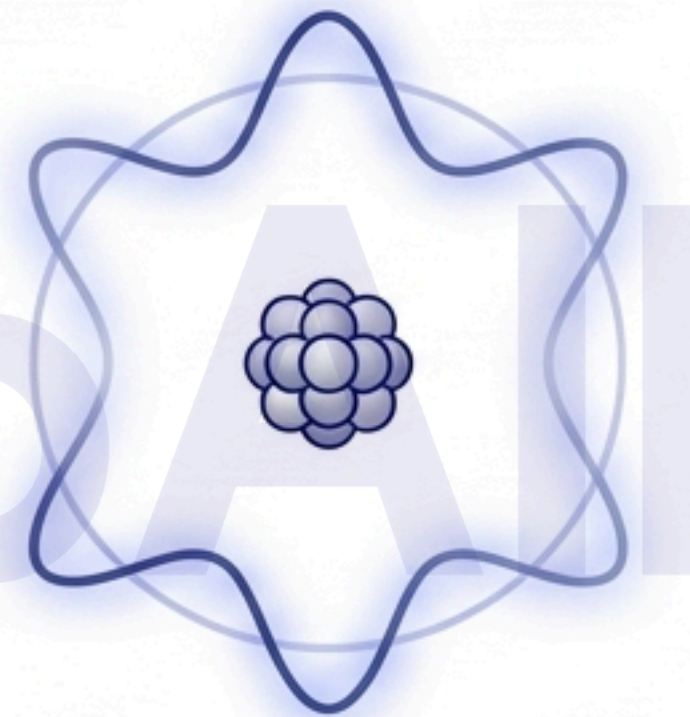
Bohr's Classical View (1913)



Treats the electron strictly as a macroscopic particle on a well-defined trajectory.



de Broglie's Reality (1924)



Matter exhibits dual behavior (particle and wave). An electron cannot be confined to a 1D rigid track.

Formula Highlight Strip

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

Macroscopic objects have undetectable wavelengths. Microscopic electrons have significant wavelengths that dictate their behavior.



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

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

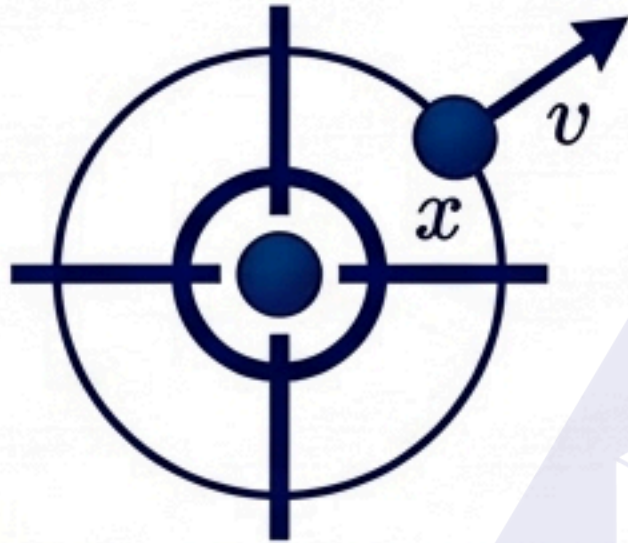
Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Conflict with Heisenberg Uncertainty Principle

Step 1: Bohr's Requirement (The Setup)



To define an orbit, Bohr requires knowing the exact **location** (x) and exact **velocity** (v) of the electron simultaneously.

Step 2: Heisenberg's Law (The Blockade)

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

Δx : position uncertainty
 Δp : momentum uncertainty

It is impossible to determine exact **position** and exact **momentum** simultaneously.

Step 3: The Contradiction (The Breakdown)



If Bohr's exact orbit is true ($\Delta x = 0$), momentum becomes infinitely uncertain.

Exam Tip

Key Takeaway: The Uncertainty Principle rules out the existence of definite paths or trajectories for sub-atomic particles. Therefore, Bohr's fixed orbits are physically impossible.

Final Recap: Bohr was useful, but not final

Synthesis Matrix

Keep (The Legacy)

- Energy levels are quantized (represented by integers, n).
- Electrons can transition between discrete energy states.
- A useful baseline for the Hydrogen atom spectrum.

Discard (The Failures)

- Fixed, circular 2D paths (orbits).
- Treating the electron purely as a classical particle.
- The concept of a definite, measurable trajectory.

The New Paradigm (1926)

$$\hat{H}\psi = E\psi$$



The Quantum Mechanical Model of Atom. Replaces fixed paths with mathematical wave functions.

Paradigm Shift: We must abandon the classical **Orbit** (a definite path) and embrace the quantum **Orbital** (a 3D region of probability density).



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis