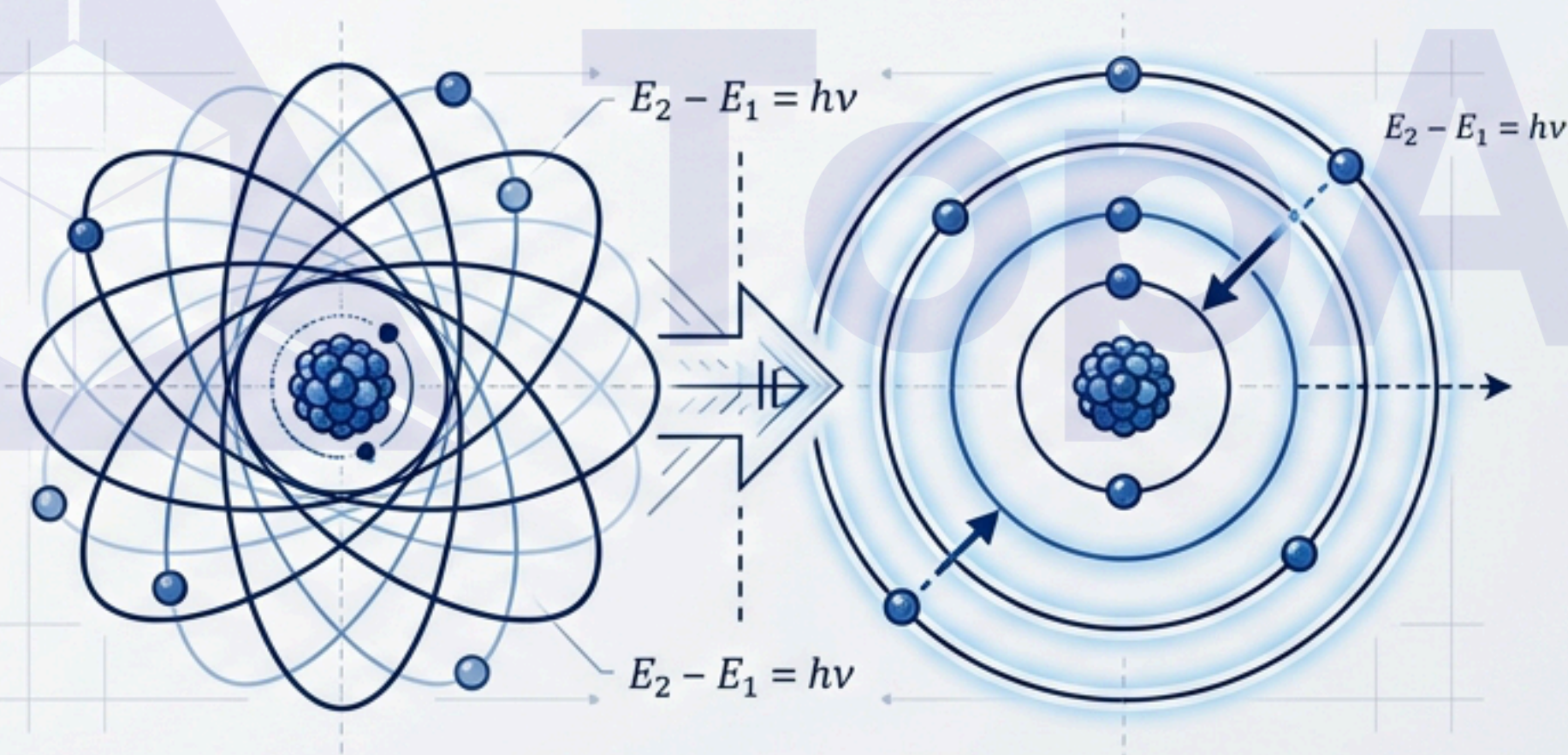


2.3 Developments Leading to the Bohr's Model of Atom

Bridging the gap between classical physics and the dawn of quantum mechanics.



Why Rutherford Model Needed Improvement

Rutherford's "solar system" model was a breakthrough, but it fatally contradicted classical physics and lacked electronic detail.

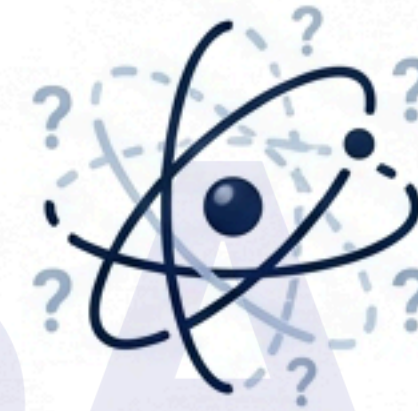


The Stability Problem

The Death Spiral

According to Maxwell's electromagnetic theory, a charged particle (electron) accelerating in an orbit must continuously emit radiation.

The electron would rapidly lose energy and spiral into the nucleus in fractions of a second. Atoms shouldn't exist!



The Structure Problem

Missing Electronic Data

The model firmly established the central dense nucleus, but said absolutely nothing about how electrons are distributed around it.

It provided no mathematical framework or logic to calculate the energies of these orbiting electrons.



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$$E=mc^2$$



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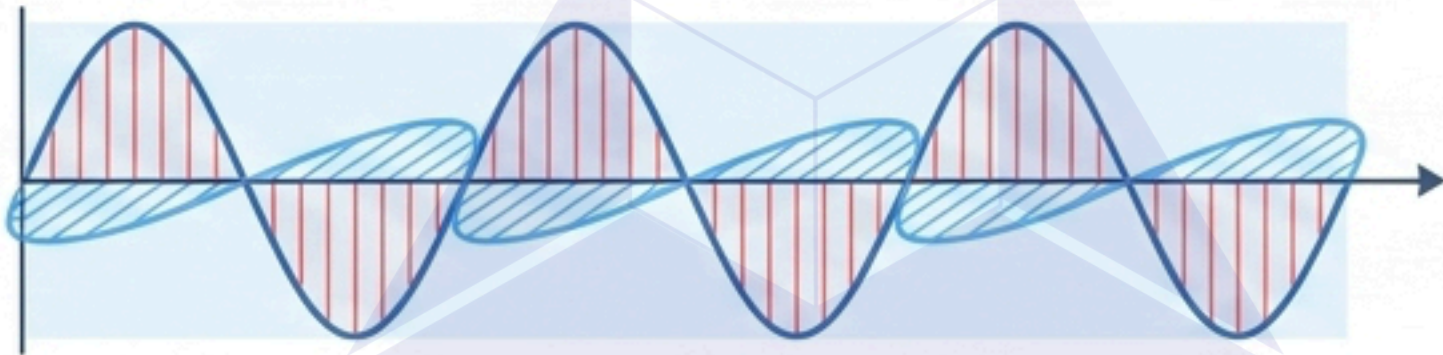


Dual Character of Radiation

To fix the atomic model, physicists first had to rethink the fundamental nature of light. Interactions between matter and radiation revealed a shocking dual nature.

Classical View

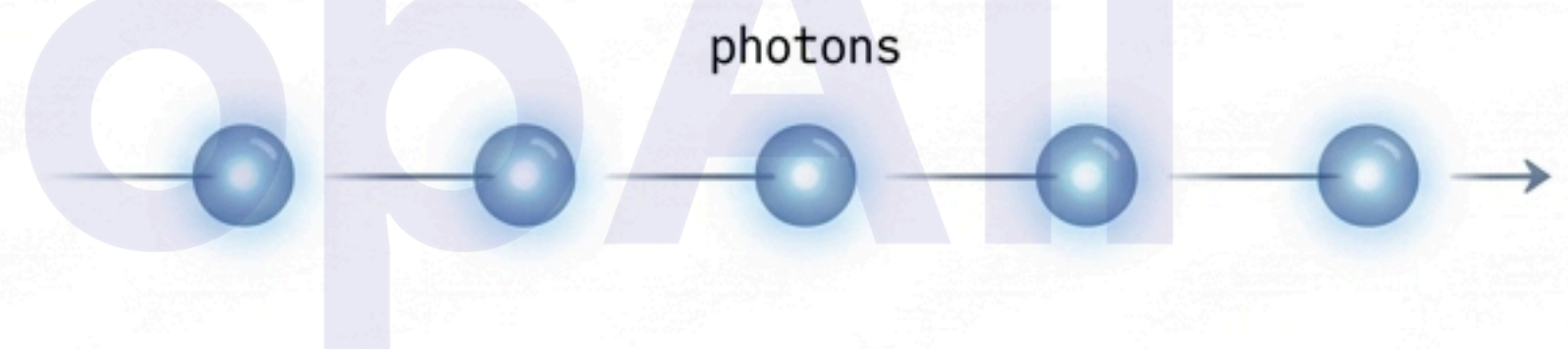
Wave Nature



Light propagates as continuous electromagnetic waves. This perfectly explains macroscopic phenomena like interference and diffraction.

Quantum View

Particle Nature



Light actually consists of discrete, indivisible packets of energy called photons. This explains microscopic phenomena like the photoelectric effect and black-body radiation.

Planck's Quantum Theory

$$E = h\nu$$

Energy is emitted or absorbed in discrete "quanta," not continuously.
 $h = 6.626 \times 10^{-34} \text{ J s}$ (Planck's constant).

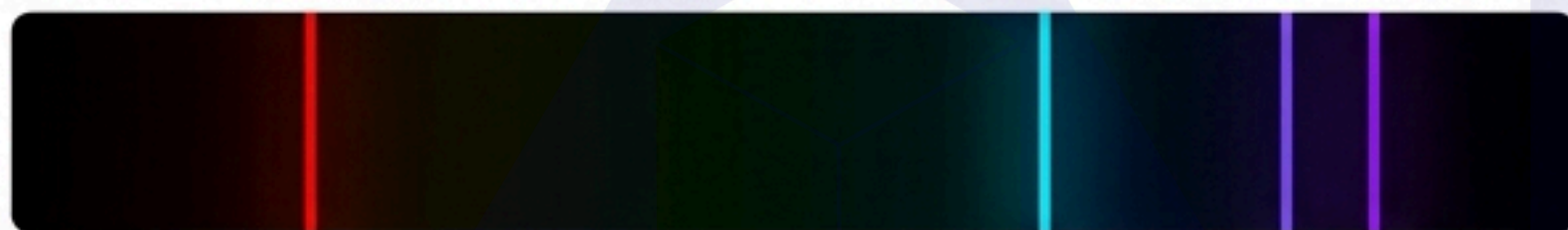
Atomic Spectra as Experimental Clue

When gases are excited, they emit light. Passing this emitted light through a prism revealed the most crucial diagnostic clue for atomic structure.



Continuous Spectrum

White light produces all wavelengths continuously (a seamless spectrum).



Line Spectrum

Excited atoms emit only specific, discrete wavelengths (e.g., Hydrogen's Balmer series).

Because atoms only emit specific frequencies of light, electrons must only exist in specific, discrete energy states.

$$\bar{\nu} = 109,677 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{cm}^{-1}$$

The **Rydberg equation** mathematically predicted these exact, distinct spectral lines for hydrogen, waiting for a physical model to explain why.

Final Recap: The Two Ideas That Guided Bohr

Niels Bohr brilliantly synthesized these two radical discoveries to rescue the atomic model from classical collapse.

Dual Character of Radiation

Quantization (Clue 1)

Energy is not a continuous flow; it exists in fixed, discrete packets (quanta).



Atomic Spectra

Discrete States (Clue 2)

Atoms only emit specific frequencies, proving internal energy levels are strictly restricted to specific values.



Bohr's Solution: Stationary States

Bohr proposed that electrons orbit the nucleus in fixed, non-radiating circular paths with strictly quantized energy levels.

Electrons only absorb or emit energy when instantly 'jumping' between these specific states, preventing the classical death spiral.



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