Need for a “New Physics”

The nuclear model demonstrated by Rutherford’s gold foil experiments did not make sense in terms of the physics known at the time.

The “new physics” that was needed to understand atomic structure grew out of studies of radiant energy.

In the 1860s James Clerk Maxwell proposed that radiant energy is propagated in waves of fluctuating electric (\(E\)) and magnetic (\(H\)) fields.

Radiant energy is **electromagnetic radiation**.

Maxwell’s electromagnetic hypothesis was confirmed by Heinrich Hertz in 1887.
**Electromagnetic Wave**

\[ E = \text{electric field vector} \]
\[ H = \text{magnetic field vector} \]
Parameters of a Wave

\[ \lambda = \text{wavelength (m, nm, Å)} \]
\[ \nu = \text{frequency (1/sec = s}^{-1} = \text{Hz)} \]
\[ A = \text{amplitude} \]

Intensity is proportional to amplitude squared:

\[ I \propto A^2 \]
Key Equations and Constants

Speed of light in vacuum:

\[ c = 2.9979 \times 10^8 \text{ m/s} \]

Relationship between \( \nu \) and \( \lambda \) in vacuum:

\[ \nu = \frac{c}{\lambda} \]

Wavenumbers (cm\(^{-1}\)):

\[ \tilde{\nu} = \frac{1}{\lambda} \]

Energy:

\[ E = h\nu = \frac{hc}{\lambda} = hc\tilde{\nu} \]

Planck's constant:

\[ h = 6.626 \times 10^{-34} \text{ J s} \]
The Electromagnetic Spectrum

\[ \lambda \quad \quad \nu \quad \quad E \]

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<th>100 nm</th>
<th>500 nm</th>
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\( \lambda = 390 \text{ nm} \)

\( \lambda = 760 \text{ nm} \)

Visible spectrum colors:
- violet
- indigo
- blue
- green
- yellow
- orange
- red