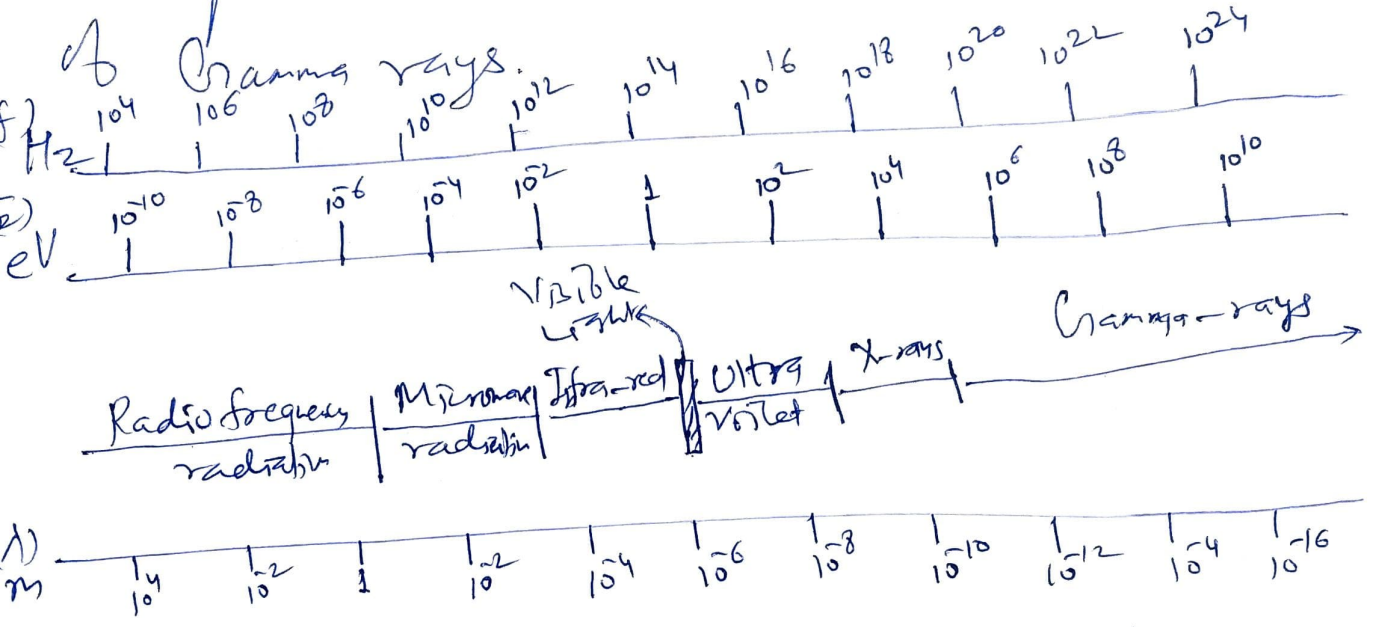
Kirchoff's Law
Black body radiation
Planck's quantum theory, P.E.

Photons & electromagnetic spectrum

$E = h\nu = hc/\lambda$

E.M Spectrum → extends from low frequencies of radio waves to high frequencies of Gamma rays.



The electromagnetic Spectrum

X-rays and Compton effect → change in wave length.

Raman scattering → no change in the wave length of incident particle

The Nuclear Atom

Atomic nature well established in early 20th century
electrons are known

Atomic Sizes

Information of atomic sizes → found from simple arguments about the nature of solids.

Assume that in a solid the atoms are packed as closely as possible.

If diameter of each atom → D

Length L of a material contains L/D atoms

and volume L^2 contains $\left(\frac{L}{D}\right)^3$ atoms.

No. of atoms in one mole of substance is equal to Avagadro's number N_A.

If the density is ρ kg m^{-3}, one mole will occupy a volume of $(10^{-3}\mu/\rho)$ m^3, μ → atomic weight.

⇒ Unit volume contains $(10^3\rho/\mu)6\times10^{23}$ atoms. → equated to $\frac{1}{D^3}$

$$\Rightarrow D = \left[\frac{\mu}{6\rho}10^{-26}\right]^{1/3}$$

$$\simeq 2\times10^{-10}\ \text{m}$$ for most of elements

Li	2.3×10^{-10}		
C	1.8×10^{-10}	Pb	3.1×10^{-10}
Fe	2.3×10^{-10}		
Ag	2.6×10^{-10}		
Au	2.6×10^{-10}		

Atomic Orbital :- Thomson Model

Experiments of Geiger, Marsden and Rutherford (1906-1913)

↓ how mass & positive charges are distributed within the atoms

Scattering of α-particles by metallic foils of various thickness.

e → electron
Cathode Rays
Thomson's method for measuring charge per unit mass (e/m)
Charge on electron 1.602189×10^{19} C
Millikan's experiment.

Bohr's Postulates

$$L = nh \qquad n = 1, 2, 3 \ldots$$

$$\nu = \frac{E_i - E_f}{h}$$

$$E = -\frac{mZ^2e^4}{(4\pi\varepsilon_0)^2 2\hbar^2}\frac{1}{n^2}$$

$n = 1, 2, 3 \ldots$

Quantization of orbital angular momentum of the electron leads to a quantization of its total energy.

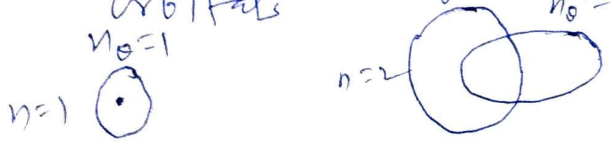
Frank-Hertz experiment. → atomic energy states are quantized.

Sommerfeld's Model

elliptical Bohr-Sommerfeld orbitals

$$\oint L\,d\theta = n_\theta h$$

$$\oint p_r\,dr = n_r h$$



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Atomic Spectra & Bohr Model of Hydrogen Atom

Newton → dispersion of white light by prism

Melvill → light from incandescent gas → large number of discrete frequencies called emission lines.

Diffraction gratings → much greater resolving power

Kirchhoff → only certain definite frequencies can be radiated or absorbed by a given element and emission frequencies coincide with the absorption frequencies

Each element has its own characteristic line Spectrum → only mean by which the presence of particular elements in sun and stars can be determined.

Line spectra of atom :- J. Balmer (1885)

He showed frequencies of a series of lines in the visible part of the spectrum of atomic hydrogen were among those given by the formula

$$\nu_{ab} = R\left(\frac{1}{n_a^2} - \frac{1}{n_b^2}\right) \quad \begin{matrix} n_a = 1, 2, \dots \\ n_b = 2, 3, \dots \end{matrix}$$

$$---(1)$$

ν_{ab} → frequency of either an emission or absorption line

n_a, n_b → positive integers, $n_b > n_a$

R → Rydberg's constant

$$\bar{\nu} = \frac{1}{\lambda} = \frac{\nu}{c} \quad \text{---(2)}$$

The Rydberg constant for hydrogen atom has the value

$$\tilde{R} = 109677.58 \text{ cm}^{-1} \quad \text{---(3)}$$

Infra-red and microwave region → MHz

$$\bar{\nu}(\text{cm}^{-1}) = \frac{10^4}{3} \nu(\text{MHz}) \quad \text{---(4)}$$

In atomic hydrogen, the series of lines with $n_a = 1$ is known as Lyman Series → Ultra-violet part of spectrum

Labelled as α, β, γ — in order of decreasing wavelength

Lyman α line ($n_b = 2$) → 1216 Å°

Series limit ($n_b = \infty$) is 912 Å°

The Balmer series ($n_a = 2$) → visible region

$H_\alpha, H_\beta, H_\gamma$ — Balmer H_α line ($n_b = 3$) → discovered by J. von Fraunhofer in the solar spectrum → C line.

H_α line → strong red line → $\lambda = 6563$ Å°

$n_b = 4$ and $n_b = 5$ → at 4861 and 4340 Å blue and violet and series limit is → 3646 Å.