ALPHA - PARTICLE SCATTERING AND RUTHERFORD'S NUCLEAR MODEL OF ATOM

Observations

A beam of Alpha particle with energy 5.5 MeV from a Radioactive substance of Bi^{214} is directed towards a thin (thickness of 2.1×10^{-7} m) metal foil made of Gold.

The scattered alpha-particles were observed through a rotatable detector consisting of zinc sulphide screen and a microscope.

Many of the Alpha particles pass through the foil with no or small angle of scattering.

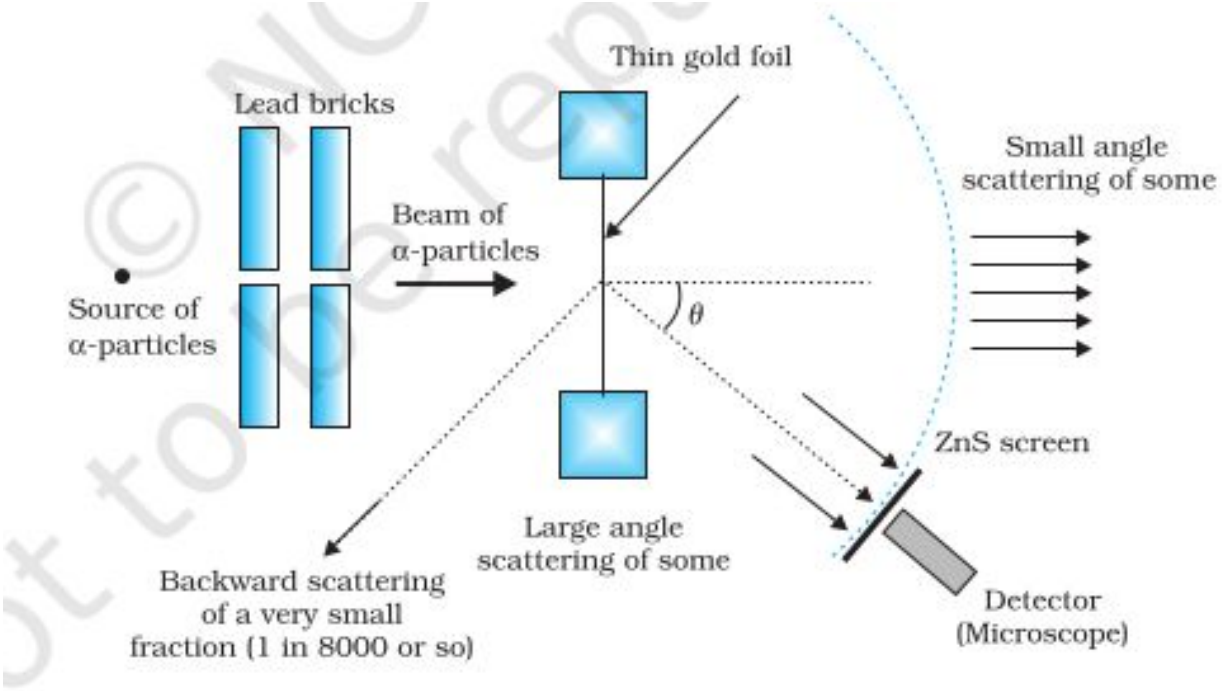
Only about 0.14% of the incident particle scatter by more than 1^{o} and about one in 8000 deflect by more than 1^{o}.

Conclusions

In Rutherford's nuclear model of the atom, the entire positive charge and most of the mass of the atom are concentrated in the nucleus with the electrons some distance away.

Size of the nucleus must be about 10^{-15} m to 10^{-14} m. Size of the atom is about 10^{-10} m. That is most of the space in atom is empty

Geiger-Marsden experiment



Alpha Particle , Gold Nucleus interaction

These are Helium nuclei with two units of positive charge (**2e)** and have the mass of the Helium atom.

The atomic number of Gold nucleus Z = 79 and it has **Ze** charge.

The Gold nucleus is taken as stationary as it is 50 times heavier than Alpha particle during collision

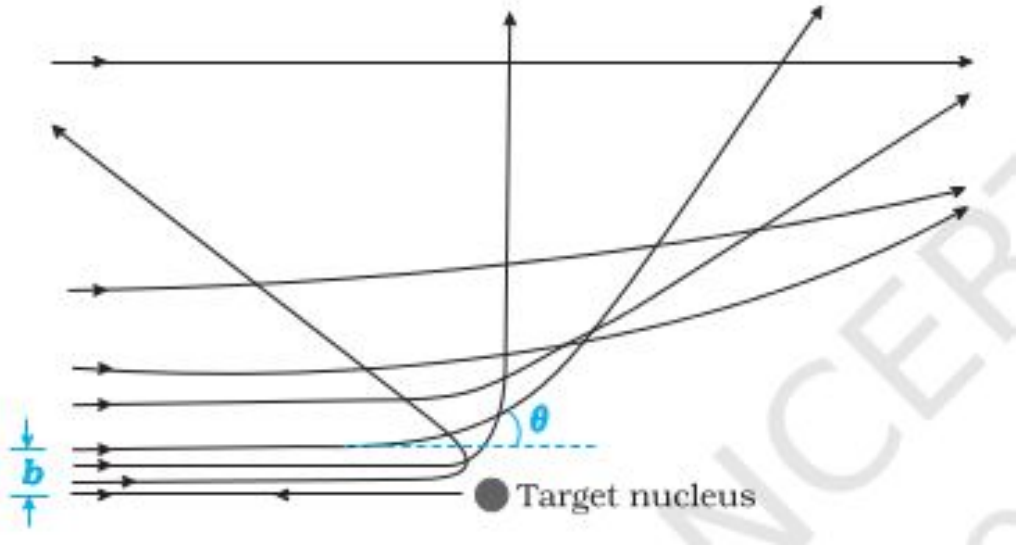
Using Coulomb's Law

$$F = \frac{1}{4\pi\epsilon_0}\frac{(2e)(Ze)}{r^2}$$

Where r is the distance between Alpha Particle and the nucleus. The magnitude and the direction of the force changes as alpha particle approaches the gold nucleus.

Alpha Particle Trajectory

The impact parameter is the perpendicular distance of the initial velocity vector of the α-particle from the centre of the nucleus.



The fact that only a small fraction of the number of incident particles rebound back indicates that the number of α-particles undergoing **head on collision** is **small**.

This, in turn, implies that the mass of the atom is **concentrated** in a **small** volume. Rutherford scattering therefore, is a powerful way to determine an upper limit to the size of the nucleus.