2. The nuclear atom

Let me begin this stody with the classical experiments of Lord Rutherford around 1911 which demonstrated that the atom is not a continuous blob of matter, but is rather a structure whose mass is concentrated in a small, central nucleus. Let me show the basic arrangement of Geiger and Marsden's experiment in his laboratory.

Rutherford's experiments made use of a beam of α-particles formed simply by collimating the particle flux emitted in all directions by a natural radioactive source. This *beam* of α-particles was then directed at a *target*, which in the case of Rutherford and collaborators was a thin foil of the material under study. The particles were then scattered into a *detector*, which in this case was a fluorescent zinc sulphide screen. This was in turn viewed by a graduate student through a small microscope. Thus we see here a typical scattering experiment—beam (collimated α-particles), target (scattering foil), and detector (fluorescent screen, microscope and graduate student). You will see that all of the more recent scattering experiments to which I will refer still have precisely these same basic components.

Scattering experiments are the most common method by which the physicist analyses the constituents of particles which are not (with the techniques available at a given epoch) accessible to *individual* observation. A scattering experiment simply measures the probability that an incident particle is scattered at a given angle away from its initial direction and in so doing either has or has not suffered an energy loss or change in some other characteristic during the scattering process. If the energy of the incident particle after deflection is diminished only by the recoil energy of the target particle without any other changes, then the scattering is called elastic; otherwise it is called inelastic.

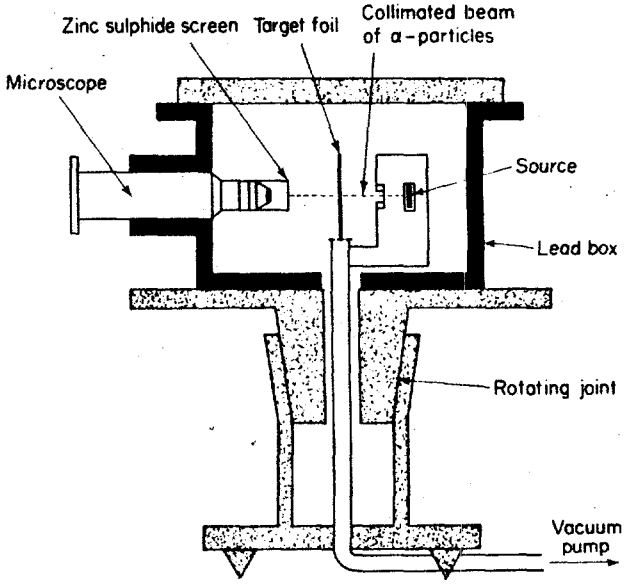

Fig. 1. Schematic diagram of Geiger and Marsden's apparatus which demonstrated the existence of the nucleus within the atom. The apparatus consists of a source of α-particles followed by a collimator which forms a beam of these particles striking a target foil. The particles then strike a zinc sulphide fluorescent screen after scattering in the foil. The location of the particles on the screen is determined by a human observer viewing the screen through a microscope.