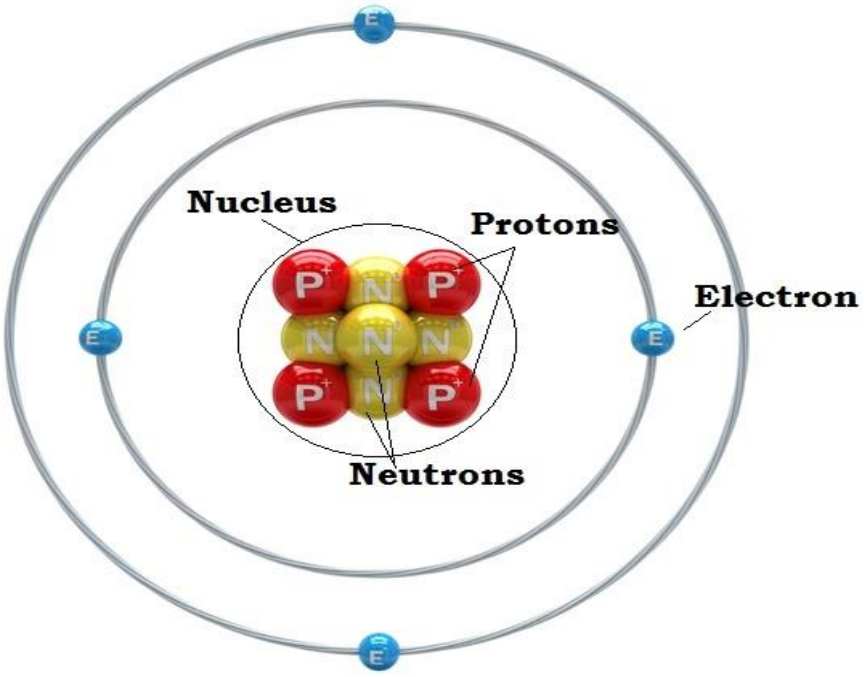
Lec 2

Structure of Atom

The word ‘atom’ has been derived from the Greek word ‘*a-tomio*’ which means ‘uncutable’or ‘non-divisible’. The atomic theory of matter was first proposed on a firm scientific basis by John Dalton.

John Dalton Model of Atom

A British school teacher in 1808. His theory, called Dalton’s atomic theory, regarded the atom as the ultimate particle of matter. These established that atoms can be further divided into subatomic particles, i.e., electrons, protons and neutrons.



Electron

In 1830, Michael Faraday showed that if electricity is passed through a solution of an electrolyte, chemical reactions occurred at the electrodes, which resulted in the liberation and deposition of matter at the electrodes. These results suggested the particulate nature of electricity. An insight into the structure of atom was obtained from the experiments on electrical discharge

through gases. A basic rule regarding the behavior of charged particles: "Like charges repel each other and unlike charges attract each other". R.A. Millikan (1868-1953) determines the charge on the electrons. He found that the charge on the electron to be -1.6×10^{-19} C. So the Definition of **Electron very small particle of matter that has a negative charge of electricity and that travels around the nucleus of an atom, or it an elementary particle consisting of a charge of negative electricity equal to about 1.6×10^{-19} coulomb.**

Protons and Neutrons:

The neutron is a subatomic particle, with no net electric charge and a mass slightly larger than that of a proton. Protons and neutrons, each with mass approximately one atomic mass unit, constitute the nucleus of an atom, and they are collectively referred to as nucleons

Electrical discharge carried out in the modified cathode ray tube led to the discovery of particles carrying positive charge, also known as canal rays. The characteristics of these positively charged particles are listed below.

1) Unlike cathode rays, the positively charged particles depend upon the nature of gas present in the cathode ray tube. These are simply the positively charged gaseous ions.

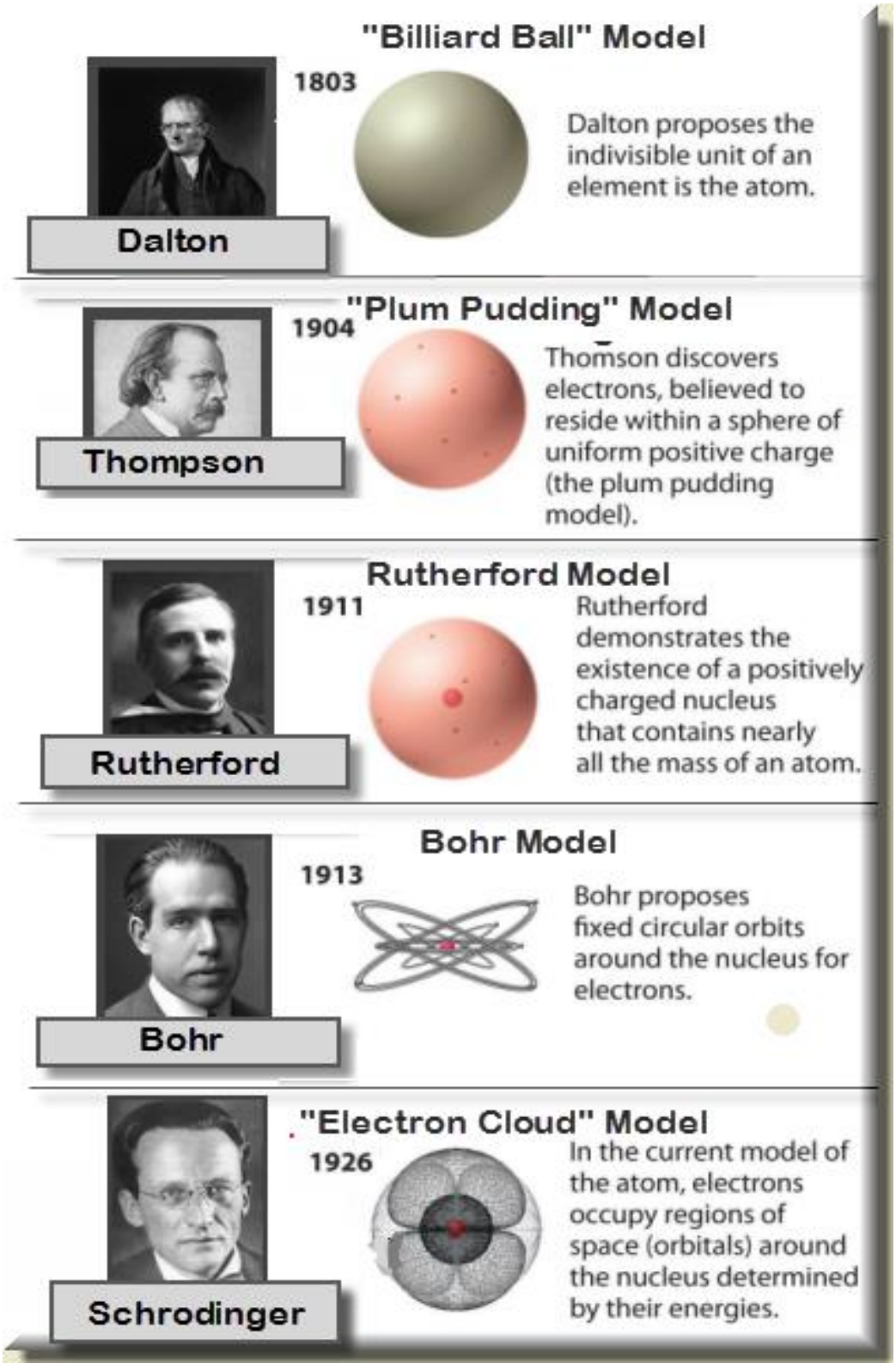
2) The behaviour of these particles in the magnetic or electrical field is opposite to that observed for electron or cathode rays. The smallest and lightest positive ion was obtained from hydrogen and was called proton. This positively charged particle was characterized in 1919. A need was felt for the presence of electrically neutral particle as one of the constituent of atom. These particles were discovered by Chadwick (1932) by bombarding a thin sheet of beryllium by a-particles. When electrically neutral particles having a mass slightly greater than that of the protons was emitted. He named these particles as neutrons.

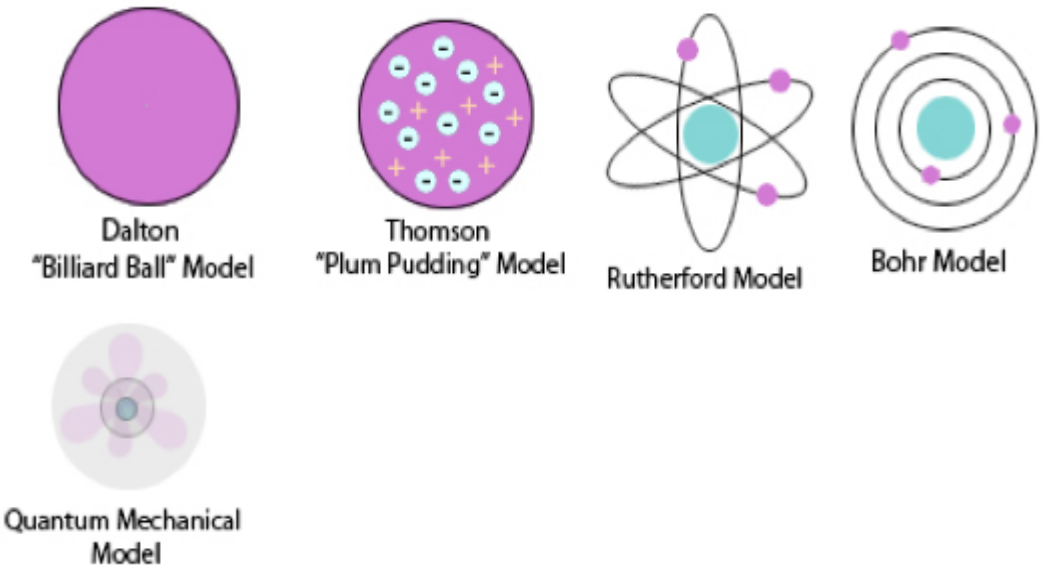
Atomic models:

Observations obtained from the experiments studies have suggested that Dalton's indivisible atom is composed of sub-atomic particles carrying positive and negative charges. Different atomic models were proposed to explain the distributions of these charged particles in an atom. Although some of these models were not able to explain the stability of atoms, two of these models, proposed by J. J. Thomson and Ernest Rutherford are discussed below.

Thomson Model of Atom

J. J. Thomson, in 1898, proposed that an atom possesses a spherical shape (radius approximately 10^{-10} m) in which the positive charge is uniformly distributed. The electrons are embedded into it in such a manner as to give the most stable electrostatic arrangement. Many different names are given to this model, for example, plum pudding, raisin pudding or watermelon. This model can be visualized as a pudding or watermelon of positive charge with plums or seeds (electrons) embedded into it. An important feature of this model is that the mass of the atom is assumed to be uniformly distributed over the atom**.** Although this model was able to explain the overall neutrality of the atom, but was not consistent with the results of later experiments.


"Billiard Ball" Model
1803
Dalton proposes the indivisible unit of an element is the atom.
Dalton
"Plum Pudding" Model
1904
Thomson discovers electrons, believed to reside within a sphere of uniform positive charge (the plum pudding model).
Thompson
Rutherford Model
1911
Rutherford demonstrates the existence of a positively charged nucleus that contains nearly all the mass of an atom.
Rutherford
Bohr Model
1913
Bohr proposes fixed circular orbits around the nucleus for electrons.
Bohr
"Electron Cloud" Model
1926
In the current model of the atom, electrons occupy regions of space (orbitals) around the nucleus determined by their energies.
Schrodinger



Rutherford's Nuclear Model of Atom

Rutherford and his students (Hans Geiger and Ernest Marsden) bombarded very thin gold foil with a–particles. Rutherford's famous a–particle scattering experiment. Stream of high energy a–particles from a radioactive source was directed at a thin foil (thickness ~ 100 nm) of gold metal. The thin gold foil had a circular fluorescent zinc sulphide screen around it. Whenever a–particles struck the screen, a tiny flash of light was produced at that point.