The Atom

Adam Kelly

September 10, 2018

Summary

- All matter is made up of small particles
- Particles are spread through diffusion
- John Dalton's atomic theory: All matter is made up of very small particles called atoms, and atoms are indivisible (can't be broken down into smaller parts, which is wrong)
- William Crookes investigates cathode rays in vacume tubes
- Cathode rays are rays of negatively charged particles (electrons), They travel in straight lines form the cathode to the anode, are deflected by electric and magnetic fields and have sufficient energy to move small objects (paddle wheel)
- J. J. Thomson showed electrons are negatively charged and measured e/m
- Robert Millikan measured the charged using his oil drop experiment
- J. J. Thomson proposed the 'plum pudding' model of the atom
- Rutherford discovered the nucleus of the atom and the existence of protons in the nucleus
- James Chadwick discovered the neutron

---

1 The First Atomic Theory

Atomic theory was first proposed by John Dalton, where he had the theory:

1. All matter is made up of very small particles called atoms
2. Atoms are indivisible (can't be broken down into smaller parts, which is wrong)

2 Discovery of the Electron

2.1 Crookes 'Maltese Cross' Experiment

- In 1875, William Crookes investigated what happens when electric current is passed through a glass tube containing air at low pressure
- He used a glass tube, with a cathode, an anode and an object, along with a high voltage power supply

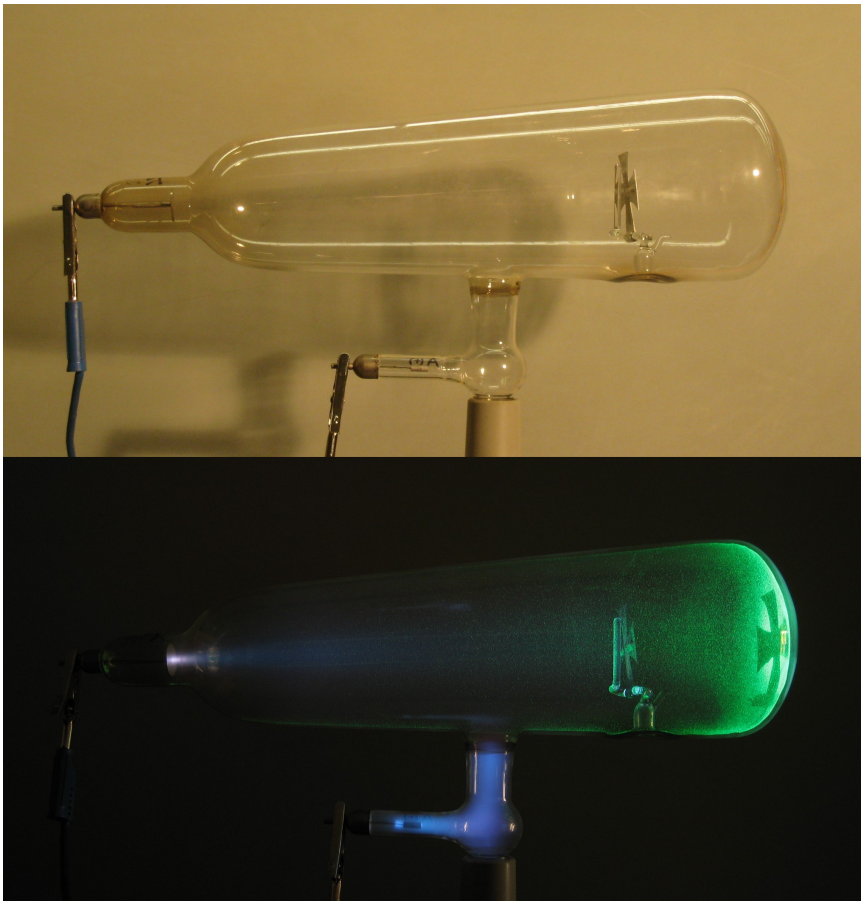

Figure 1: Crookes Tube

- He found radiation from the cathode
- Shown by putting an object (a maltese cross) in the glass, which shows a 'shadow'
- Described these as cathode rays (which are rays of electrons)
- The cathode rays cause a glowing

2.2 Crookes 'Paddle Wheel' Experiment

To investigate the properties of these cathode rays, crookes set up another experiment.

- A light paddle wheel was placed in front of the cathode
- When the current was switched on, the paddle wheel moved
- The wheels vanes always moved away
- The canes were being struck by particles, coming from the cathode

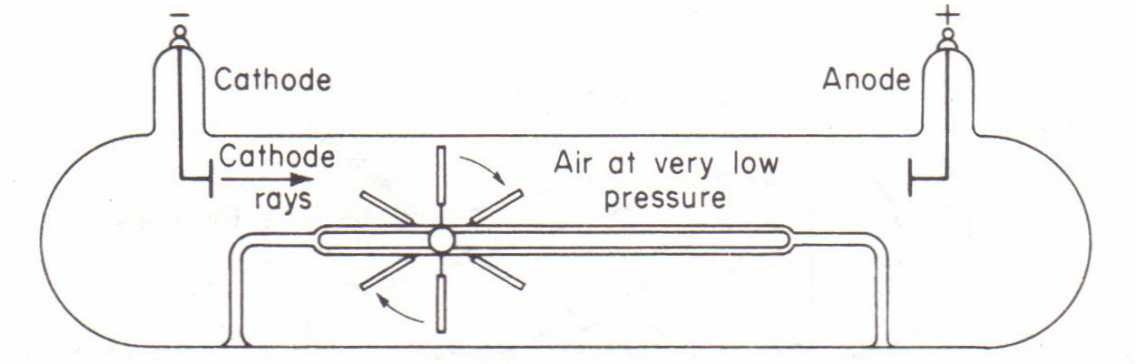

Figure 2: Experiment Diagram

The following conclusions were drawn

- Cathode rays travel in straight lines
- Cathode rays cause the glasses phosphor coating to glow
- Cathode rays have enough energy to turn a paddle wheel

2.3 Thomson's Cathode Ray Experiment

At the end of the 19th century, J.J. Thomson tried to resolve some outlying issues with cathode rays. He constructed a cathode ray tube that allowed the use of two electrodes to show that the cathode rays had a negative charge.

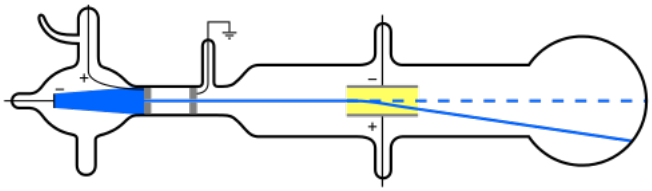

Figure 3: Experiment diagram

From this Thomson proposed a **plum pudding** model of the atom

2.4 Millikan's Oil Drop Experiment

After Thomson's experiment, it was not universally accepted that subatomic particles exist. Millikan wanted to measure the charge of an electron (which could also give the mass).

- Tiny droplets of oil were sprayed between two charged metal plates.
- X-rays were used to ionise the air between the plates (the molecules in the air lost electrons and formed ions)
- When the oil droplets fell through the air they picked up these electrons, becoming negatively charged.
- Using a microscope, a particular oil droplet was focused on, and millikan observed that the negatively charged droplet was attracted to the positive plate.

- The charge of the plates were adjusted until the oil droplet was stationary, and the size of the electron's charge

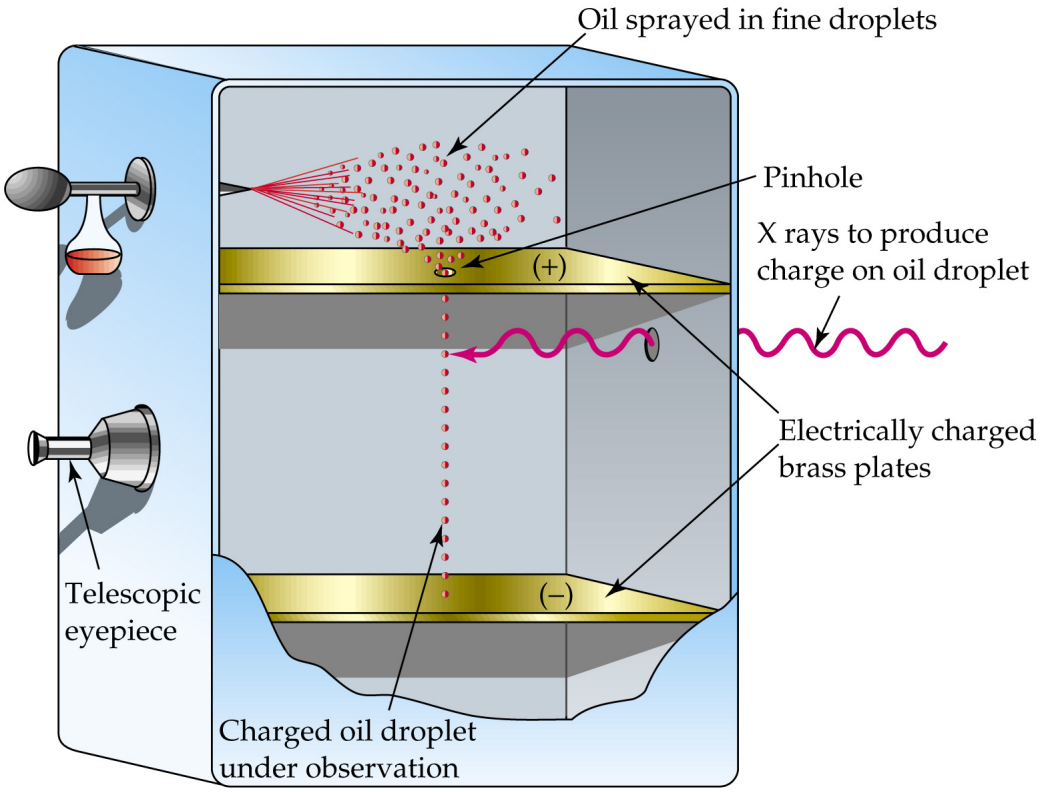

Figure 4: Diagram

2.5 The Plum Pudding Model of the Atom

After his experiments, Thomson proposed a simple model of the atom:

- An atom like a sphere of positive
- Electrons are embedded in the sphere at random.

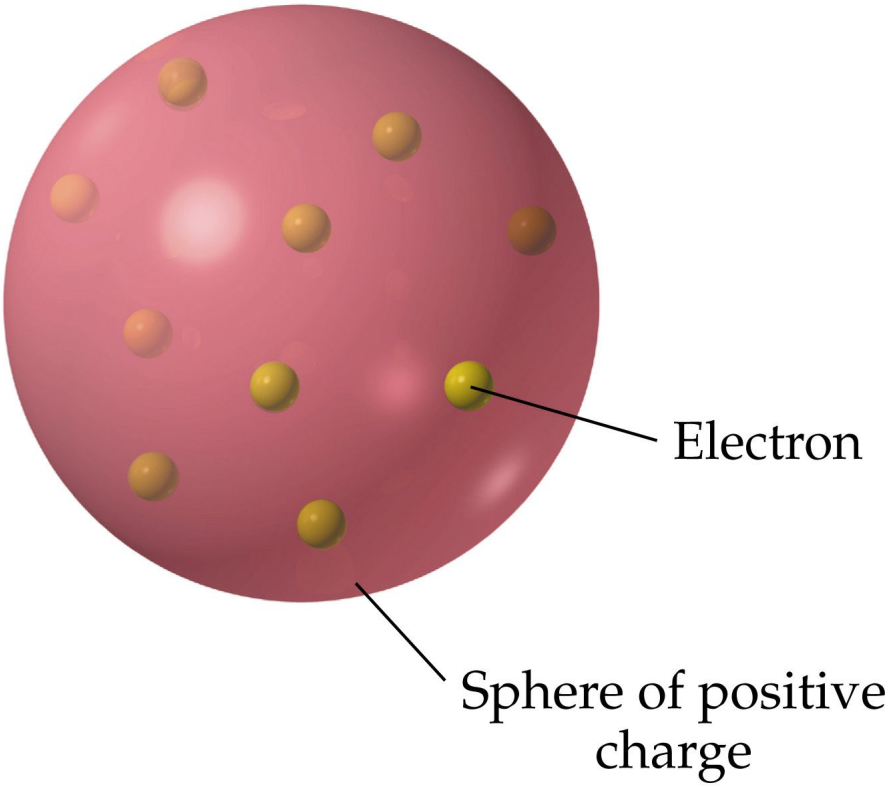

Figure 5: Plum Pudding

2.6 Discovery of the Nucleus

Ernest Rutherford did the experiment of bombarding a sheet of gold with alpha particles.

DEFINITION

Alpha Particles.

Positively charged particles produced by certain radioactive substances. They consist of two neutrons and two protons stuck together.

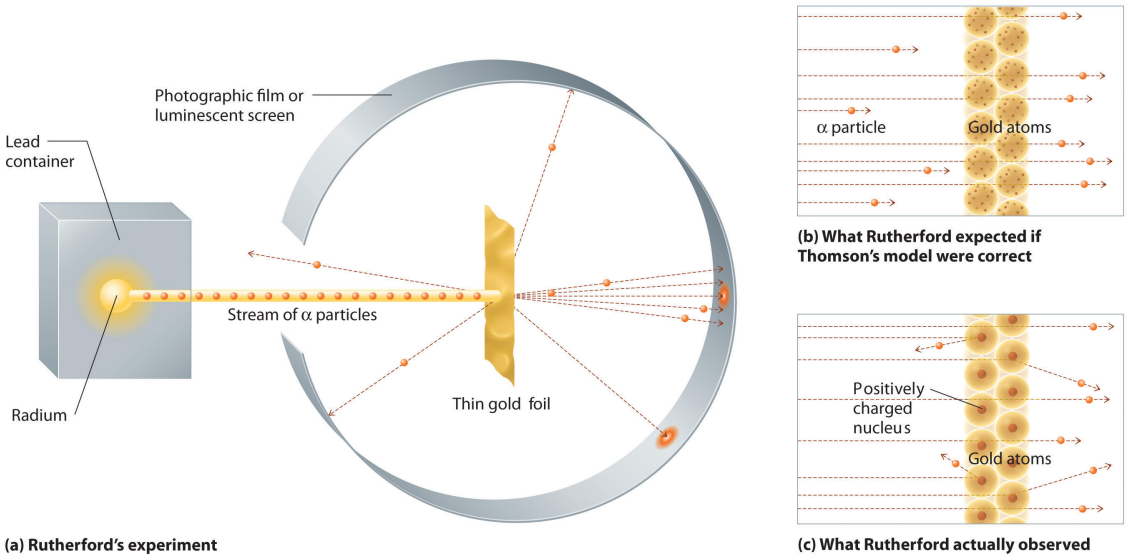

Figure 6: The experiment carried out by Rutherford to investigate how alpha particles were scattered by a piece of gold foil.

- A thin piece of gold foil was bombarded with alpha particles
- It was expected that the alpha particles would be deflected by small amounts.
- A phosphorescent screen was used to detect the alpha particles
- Rutherford found some alpha particles were deflected at large angles, and some were deflected along their own paths.

The following conclusions were made.

Observation	**Conclusion**
Most alpha particles pass straight through the gold foil.	Most of the atom is empty space.
Some alpha particles are deflected at large angles.	The alpha particles are repelled when they pass near the small, positive nucleus.
A small number of alpha particles are reflected back along their own paths.	A small number of alpha particles collide head on with the nucleus.

2.7 Discovery of The Proton

Rutherford continued his experiment of bombardment with alpha particles, but he switched to nitrogen and oxygen (which are lighter elements)
He found that small positive particles were given off - protons.

2.8 Discovery of the Neutron

James Chadwick bombarded beryllium, and found similar results. He discovered some type of radiation made up of particles with no charge coming from the beryllium. These particles had about the same mass as the proton, and he named them *neutrons*.

3 Properties of the Sub-Atomic Particles

	Relative Charge	*Relative Mass*	*Location*
Proton	+1	1	Nucleus
Neutron	0	1	Nucleus
Electron	-1	1/1838	Outside Nucleus