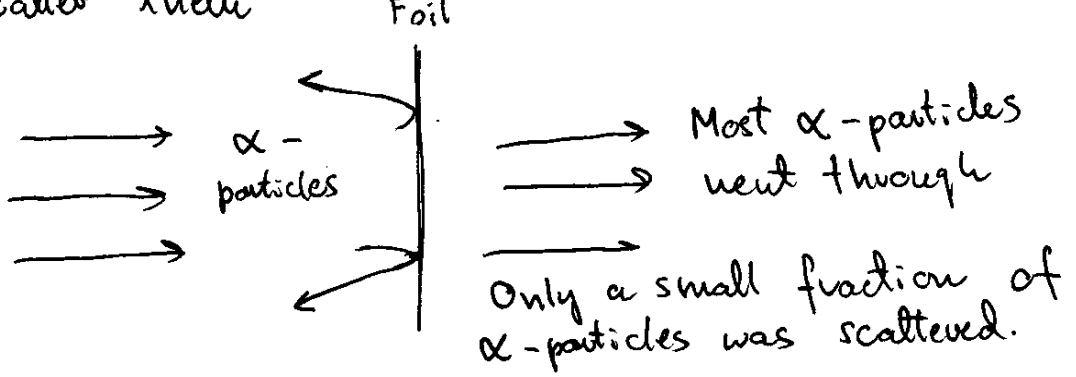
Rutherford experiment (very briefly).

It was a historic experiment that provided the first conclusive information of the structure of atoms. It showed that one of the atom's component is a positively charged nucleus of a very small size.

Electrons had been already discovered prior to the Rutherford experiment. So, it could be concluded from the experiment that the atom consisted of the positive nucleus and negative electrons, and thus had no (not) electric charge.

Rutherford bombarded thin foil of gold (Au) with α-particles. α-particles are much heavier than electrons, so they could not scatter them



Only heavy objects could scatter the α-particles. So, it meant that the gold atoms included a heavy nucleus.

However, the fact that only a very small fraction of the α-particles was scattered meant that the nuclei were very small.

Rutherford, based on his results, was able to determine the radius of the nucleus to be $\sim 10^{-14}$ m.

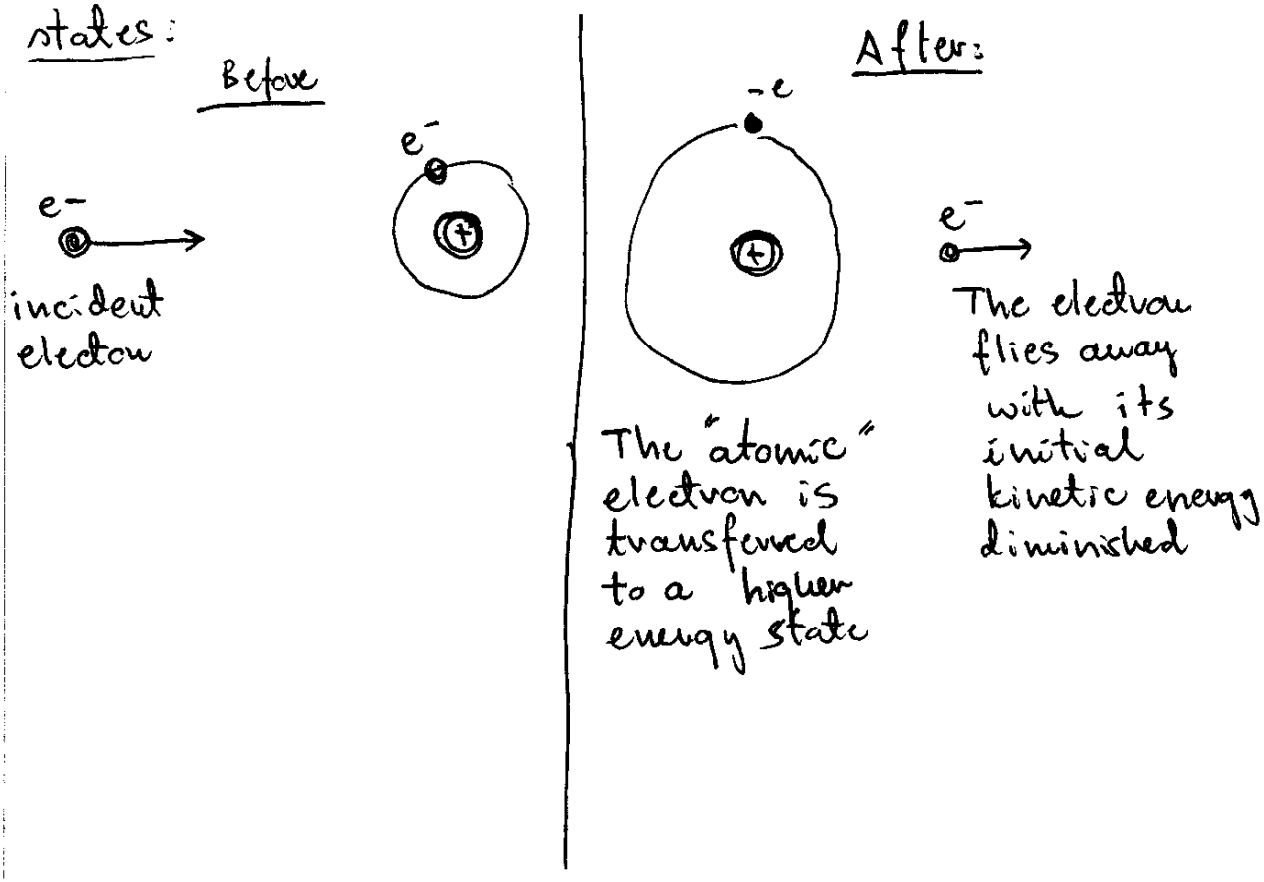
The size of an atom is $\sim 10^{-9}$ m. Assuming that the electron size is similar to the nucleus size, one can say that "atoms consist mainly of empty space" (this is not exactly true).

The Rutherford's results provided inspiration for Niels Bohr for constructing the first quantitative model of an atom - the so-called "planetary model".

The Franck-Hertz experiment

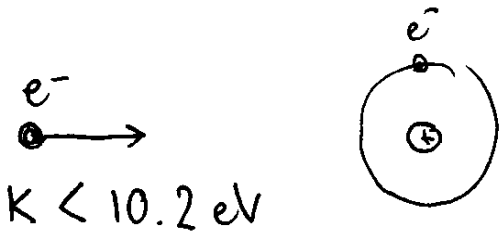
It was another historic experiment that offered insight into the structure of atoms.

It showed that if an electron collides with an atom, it can excite the electrons belonging to the atom to higher energy states:



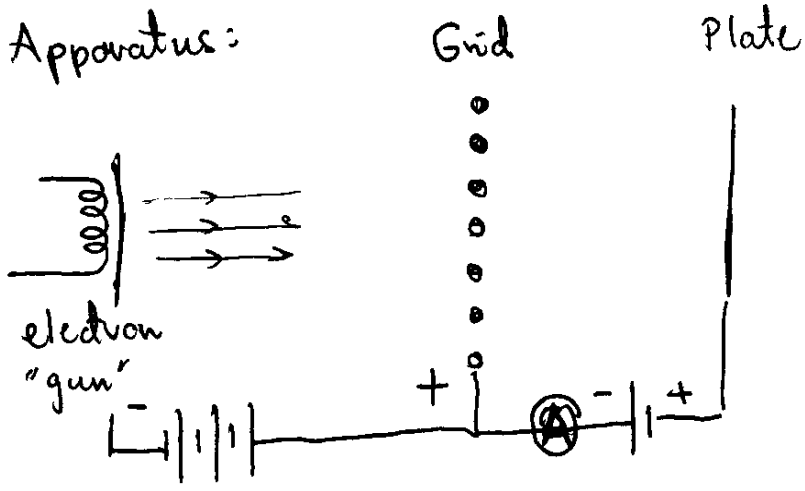
The Franck-Hertz experiment showed that the excitation process is a "threshold process."

If the "bombarded" atoms are hydrogen atoms:



Only if the incident electrons have kinetic energy > 10.2 eV, the excitation process may occur.

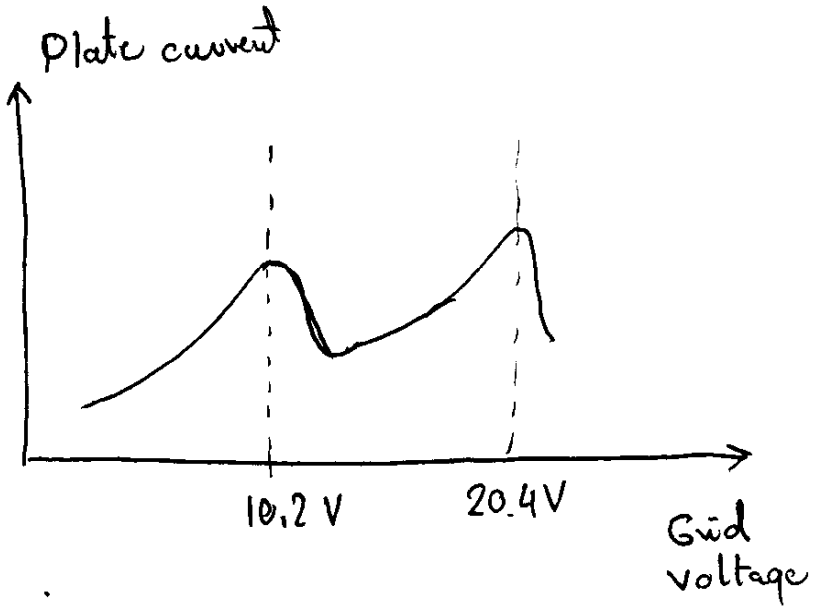
What does this mean? Well, it means that the electrons in a H atom may occupy only certain <u>discrete</u> energy levels. and the first excited level is 10.2 eV above the lowest state, in which the electron normally resides.



The potential applied between the "electron gun" and the grid accelerates the electrons. The electrons can fly past the grid. There is a small (a few volts) "retarding potential" applied between the grid and the plate.

When the incident electron energy approaches 10.2 eV, but is still lower — the electrons cannot excite the hydrogen atoms and loose energy in the process. Therefore, they go through the grid and have enough energy to fly through the "retarding potential", and reach the plate.

But if the electron energy is larger than 10.2eV, they start engaging into collisions and loose a substantial part of energy. They get past the grid with very little energy remaining, and cannot reach the plate any longer.



When the grid voltage reaches 10.2 V, there is a sudden "dip" in the plate current.

Another 'dip" occurs for 20.4V – due to electrons engaging in ~~[illegible]~~ two ~~[illegible]~~ consecutive collisions.