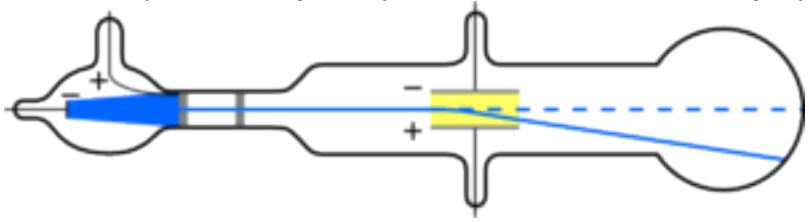
Quantum Mechanical model Summary

History

Democritus 440 B.C – First person to believe that things are made up of tiny indivisible parts called "atomos".

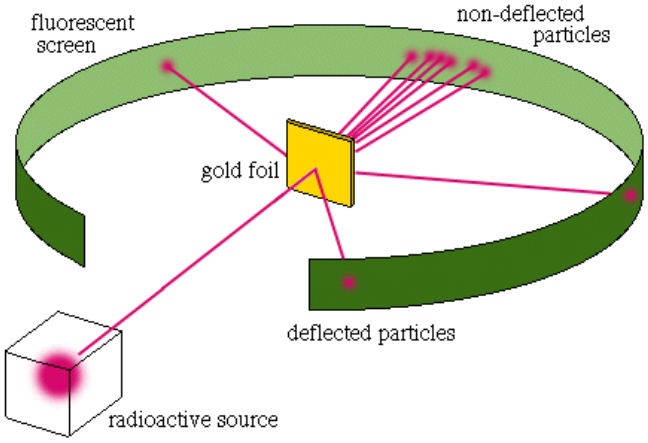
J.J. Thompson – Used CRT (Cathode ray tube) and found that cathode rays (negative) can be deflected by



an electric field.

Rutherford - Nobel Prize Winner – Used his gold foil experiment and proved a nucleus existed.

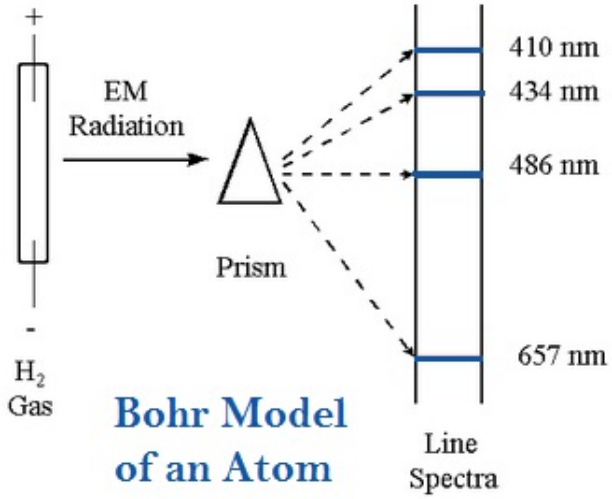
He shot alpha particles (+) and shot it at a slim piece of gold foil. At the time, it is expected that the alpha particles would go through the gold foil. But what Rutherford observed was that there were deflections indication that the alpha particles hit something substantially large. It turns out that it was the nucleus of the atoms.



Rutherford further proposed that the nucleus contains the protons and electrons circled around. But based on classical physics, any accelerated charges will give off energy and as a result, the electrons that are accelerated around the nucleus will eventually lose energy and spiral into the nucleus.

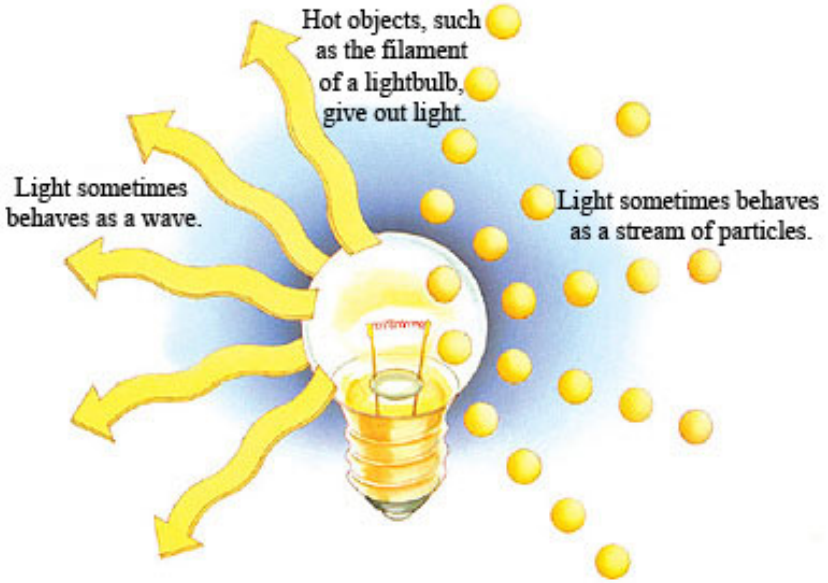
Neils Bohr- Nobel Prize Winner

Proposed that electrons were in quanta or packets of energy. Electrons were found in specific energy levels and cannot be found in between. This explains the specific line spectra that are observed in various elements. When an element is excited, the electrons will jump into a higher energy level (excited state) and once it settles down, it will go back down to the ground state while dumping out a packet of photon (or energy). The distance of where the electrons end up jumping determines the energy or the wavelength of the photon given off. The wavelength will give off the distinct unique colour.



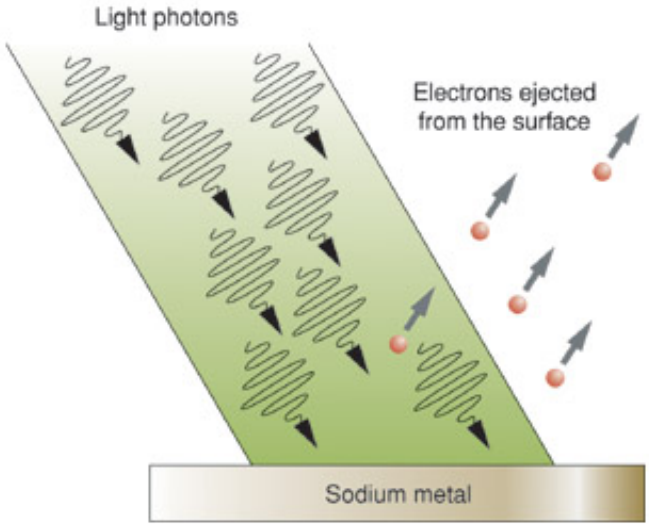
Max Planck - Nobel Prize Winner

Proposed that energy were in discrete packets of energy. Found the relationship between wavelength, and energy.



Einstein - Nobel Prize Winner

Won his Nobel prize based on his theory of the photoelectric effect. Throughout this whole debate, Einstein continued to believe that electrons behaved like particles instead of waves. He doesn't believe that "God plays dice" since if it behaved like a wave, you wouldn't be able to tell where it is. The photoelectric effect is when electrons are given of when light is shone on the metal. He found light is able to have mass which proves that light can behave like a particle.



De Broglie – Nobel Prize Winner

Believed that electrons behave like a wave and in order for the electrons to "orbit" around the nucleus, the wavelength must be a whole number to fit around the orbit. It cannot be part of a whole number.

Heisenberg – suggested the uncertainty principle where it is impossible to determine the momentum and the position of the electron at the same time. If one were to accurately find the position of the electron by bombarding a light beam and recording the deflection, then the position could be accurately calculated but as more light beams are bombarded, the more the momentum is lost. Thus, the more accurate you can find for one, the less accurate the other will become.

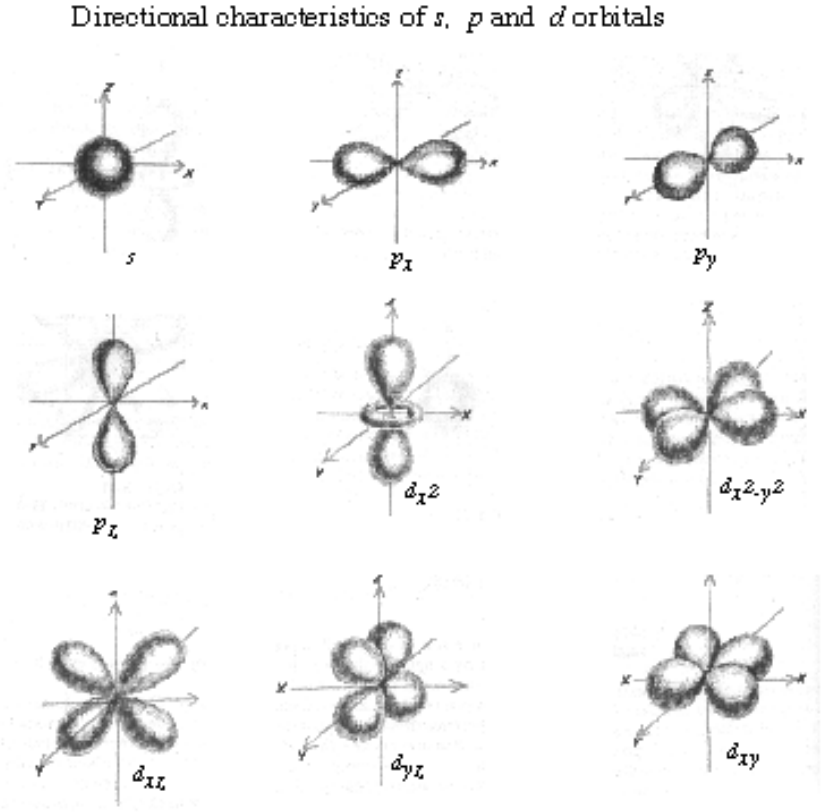
Schrodinger – The infamous thought experiment where a Cat is placed in an enclosed container with a flask of poison and a radioactive source. If the radioactive source decays, then it will break open the flask killing the cat. This thought experiment is Schrodinger's way of explaining quantum mechanics where the cat inside the box can be both alive and dead at the same time. There is no way of finding out until you open the box, where we will see the cat either alive or dead but not both. Schrodinger calculated the probability of where the electrons are located. This led to the quantum model of the atom where electrons are in orbitals of where electrons are located compared to the conventional Bohr model of orbits.

Quantum model numbers

Electrons are classified based on their quantum numbers. Compared to the conventional Bohr models, electrons are now found in orbitals where electrons are probably located. These quantum numbers indicate the electrons "address" or where they are located based on their Principle Quantum Number (energy level)(n), Angular momentum quantum number (how they are located) (l)and their spin (m_l).

Basically, the larger the quantum number (n), the higher the energy. The Principle Quantum number is simply the period of where the element is located. Hydrogen has a Principle quantum number 1, and Oxygen has principle quantum number 2 etc…

The angular momentum number (l) is the shape of the orbitals. There are 4 letters indicated 4 different shapes. S, p, d, f



The magnetic quantum number describes how the orbitals are oriented in space.

In summary, the quantum numbers provide the electrons the address in where and how they are located. It starts off with the principle quantum number, this is similar to the "city" of where you live. The higher the principle quantum number, the higher the energy. Once you have the principle quantum number, you must identify the "street" of the city, and this is the angular momentum number. This number indicates the shape of the orbitals (where electrons are found). S orbitals are spherical shape. P orbitals are dumbbell shape. D orbitals are flower shape, and F orbitals have 7 combinations. The next number, magnetic quantum number, describes how the sub-orbitals of the main orbitals are oriented. S orbitals have just 1 type and that is spherical. P orbitals have 3 different subshells. Px, Py, and Pz. D orbitals have 5 types while f has 7 types. Each sub-orbital can contain a maximum of 2 electrons each. So for the s orbital, you can have a maximum of 2 electrons since it doesn't have any sub-orbitals. P orbitals can have a maximum of 6 electrons since it has 3 sub-orbitals with 2 electrons in each. D orbitals can have a maximum of 10 electrons because it has 5 sub-orbitals and F orbitals can have a maximum of 14 electrons because it has 7 sub-orbitals.