The Atom

Describe a model of the atom that features a small nucleus surrounded by electrons.

A guy by the name of Bohr created a model for the atom that consisted of an small nucleus surrounded by orbiting electrons. There was an assumption that the electrons, literally orbited the nucleus in a similar way to how planets orbit a star. This model, often referred to as "the Bohr model," does a very good job of describing many of the properties of the hydrogen atom, but fails to describe more complex atoms.

An electrically charged particle that accelerates gives of electromagnetic waves, light. If the electrons where moving in a circular path they would be constantly accelerating and thus constantly discharging energy in the form of light. This would cause the electron to spiral into the nucleus and we would see constant light emission. Neither of these happen, a new model is needed.

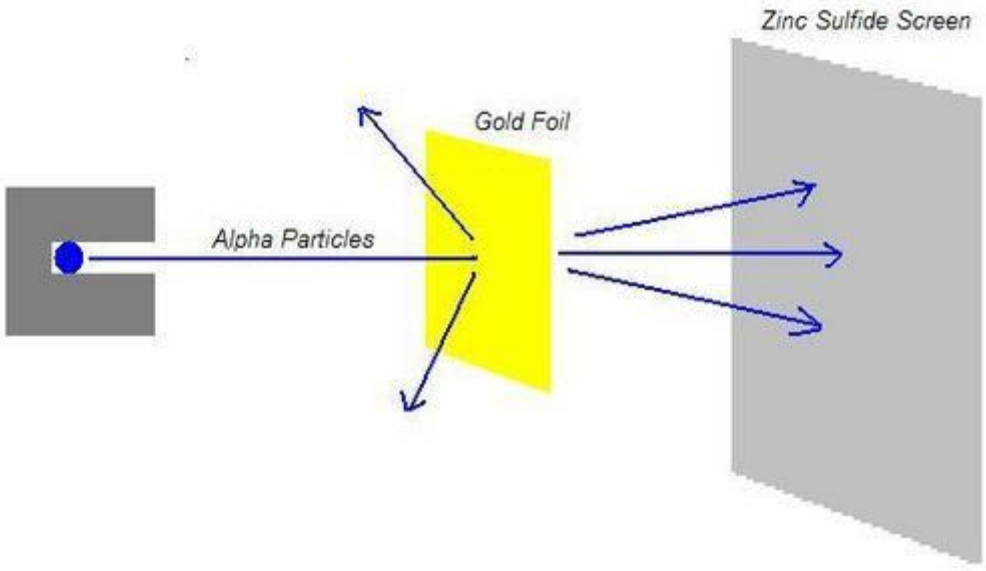
A new model consists of orbital rather than orbits. The electrons still surround the nucleus, but they do not follow a path so to speak. Instead of having a path to follow, there is a region where the electron is likely to be. The orbital never overlaps the nucleus. Some orbitals are not continuous, meaning there are 2 or more regions where a single electron is likely to be, but the electron is never in the space between the orbitals, yet the electron can be in both regions…

Outline the evidence that supports a nuclear model of the atom

A qualitative explanation of the Geiger-Marsen experiment and its results is all that is required

One of the first models for the atom was called the plum pudding model. The model was of an atom that was a mix of positive and negative charges equally distributed inside of the atom, i.e. the density of the atom was uniform.

Two guys Geiger and Marsen were working with Ernest Rutherford (as graduate students?), they conducted an experiment to explore the insides of the atom. They shot alpha particles at a thin gold foil, to detect the alpha particles after they pasted through the gold file they used a screen of zinc sulfide which briefly glows when struck by the fast moving and charged alpha particles.



The expectation was that the particles would pass through the pudding of the atom and be deflected little if any. What they found was that the vast majority pasted straight through the nucleus, a few where deflected a little, but to their surprise they found that some were deflected at large angles and some were even reflected backwards!

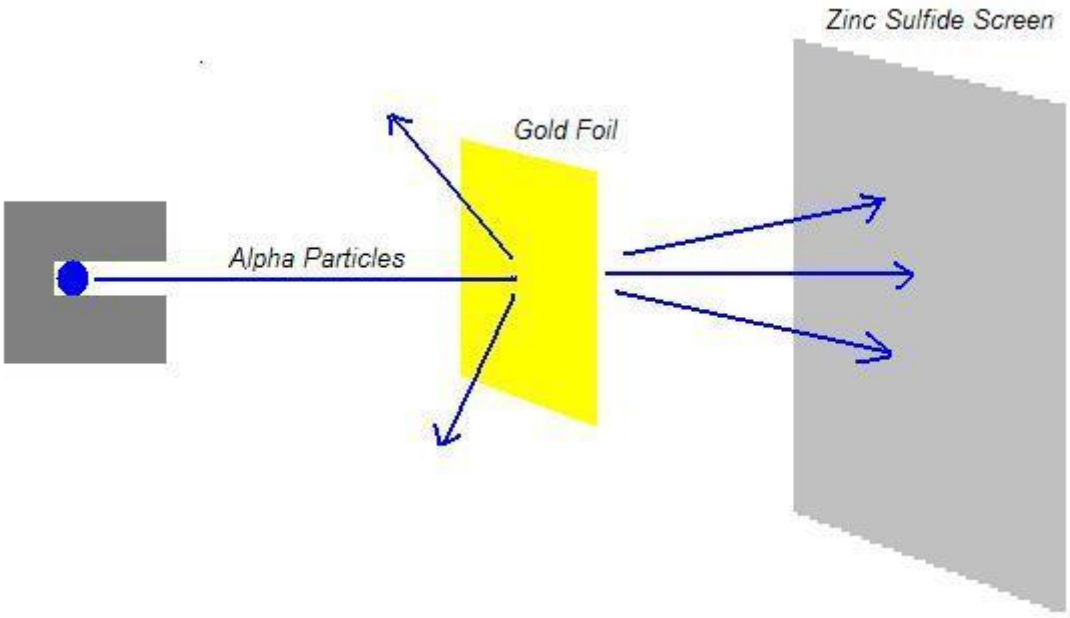
At the time they did not know that alpha particles were Helium nuclei, but they knew they had a positive electric charge and had mass. Thus the only conclusion that could be made from the experiment was that the atom had a very small positively charge center, now called the nucleus. The majority of the alpha particles were not deflected because the inside of the atom is almost entirely empty space, the few that were deflected slightly had their trajectory altered by the repulsive electric force between the alpha particle and the positively charged nucleus and the few that got reflected backwards "hit" the nucleus like a ball bouncing off the floor. They set out to prove the plum pudding model and discovered the nucleus… not bad for a couple of graduate students.

Outline evidence for the existence of atomic energy levels

Students should be familiar with emission and absorption spectra, but the details of atomic models are not required.

The Bohr model of the atom has electrons orbiting the nucleus at distinct energy levels, i.e. only certain orbits/energies are allowed. If a glass tube is evacuated and the air is replaced with the gas of a single element (molecules work too) and then an

electric current is passed through the gas then the gas will start to glow. It was found that the color of the light given off by an element is distinctive of that element. If the light given off is spilt into its individual colors or wavelengths (or frequencies) it was found that the light is not continuous but there are just a few colors given off. Below are the spectra given off by hydrogen, helium and oxygen, these spectra are known as emission spectra.



When light white passes through a gas, the gas absorbs some of the light. The light that is observed is exactly the same wavelengths that the gas emits when it is excited… The spectra of light that is not absorbed by a gas is called the absorption spectra. Emission and absorption spectra are exactly opposite.

When the gas is excited the energy added to the atom(s) excites an electron to a higher or more energetic orbit, after a short period of time the electron de-excites and falls back to its original orbit. In the process the electron losses energy in the form of a photon (light), the energy of the photon is equal to the energy difference between the two orbits. When white light is incident on a gas only the photons with exactly the right amount of energy to excite the electrons are absorbed, when the electron de-excites the energy is released in a photon but in a random direction, thus causing a dark line in the spectra. The uniformity of the emission and absorption spectra are evidence for atomic energy levels.

Describe the existence of isotopes as evidence for neutrons

Explain the terms nuclide, isotope and nucleon

Define mass number and atomic number

Not all atoms of a given element have the same mass, yet they have all the same chemical properties. Atoms of the same element but that do not have the same mass are called isotopes. This suggested that there is some electrically neutral particle that has mass inside the atom. The existence of isotopes is evidence for neutrons.

The term nuclide refers to a specific isotope. The term nucleon refers to particles in the nucleus, i.e. protons and neutrons. The mass number of an atom is the sum of the nucleons in an atom. The atomic number is the number of protons.

Thus the atomic number defines what element an atom is and if two atoms have the same atomic number but different mass numbers then they are isotopes… gee that was tough.

Describe the interactions in the nucleus.

The width of the an atom is approximately one ten-billionths of a meter or:

One tenth of a nanometer is one angstrom. While the width of the nucleus is approximately ten thousand times smaller or about . Which means that the positively charged protons are very close together and because of their like charge the protons are repelled from one another with enormous force. So how is the nucleus stable, how does it stay together? That's the role of the neutrons, at VERY small distances, less than the strong nuclear force attracts the protons to the neutrons so forcefully as to overcome the electric force… As the number of protons is increased in the nucleus the number of neutrons must also increase, for small atoms the number of neutrons to protons is roughly equal. However as the atoms get larger the number of neutrons becomes larger and larger in.

Source: http://ibphysicsstuff.wikidot.com/the-atom