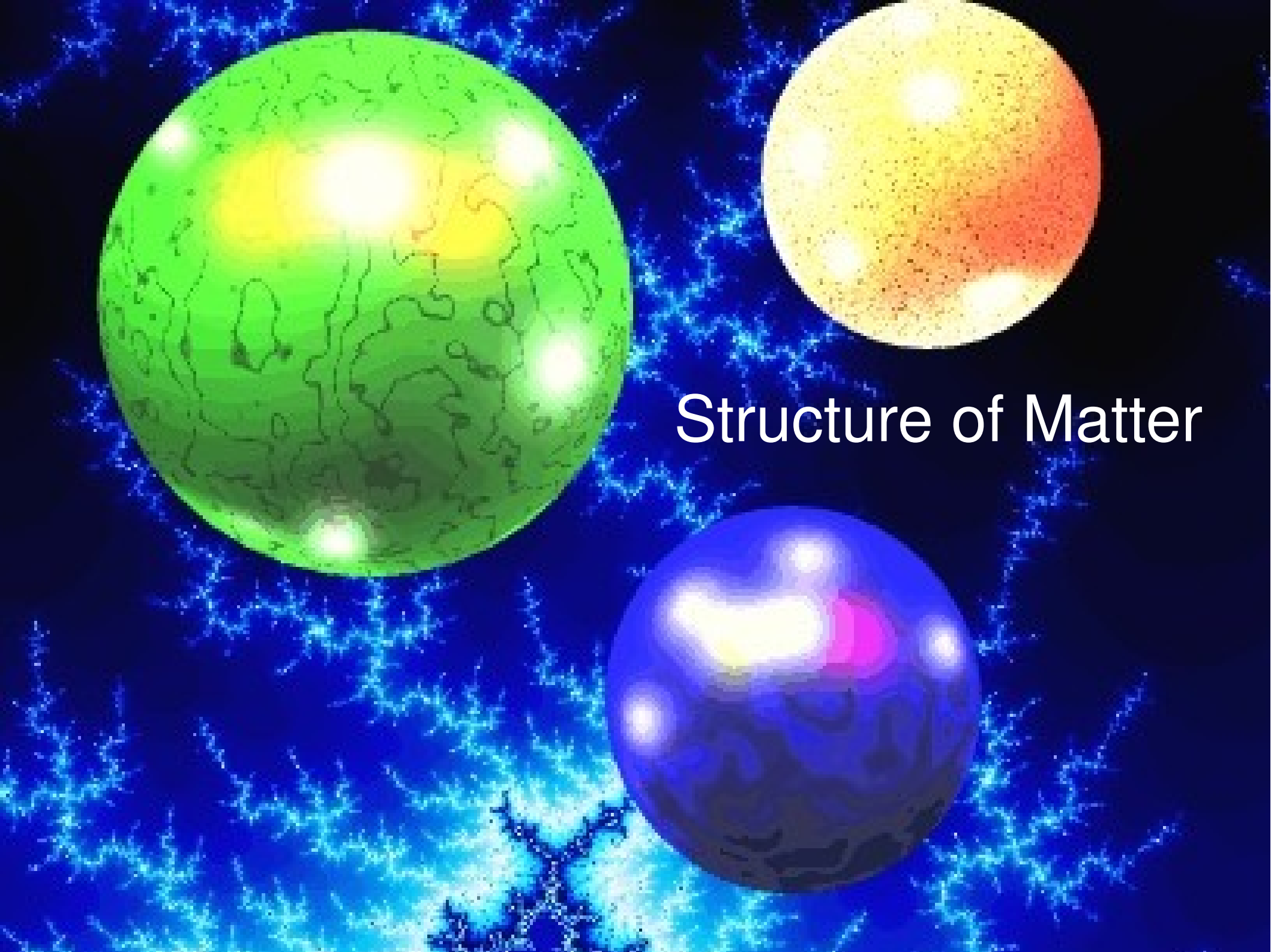
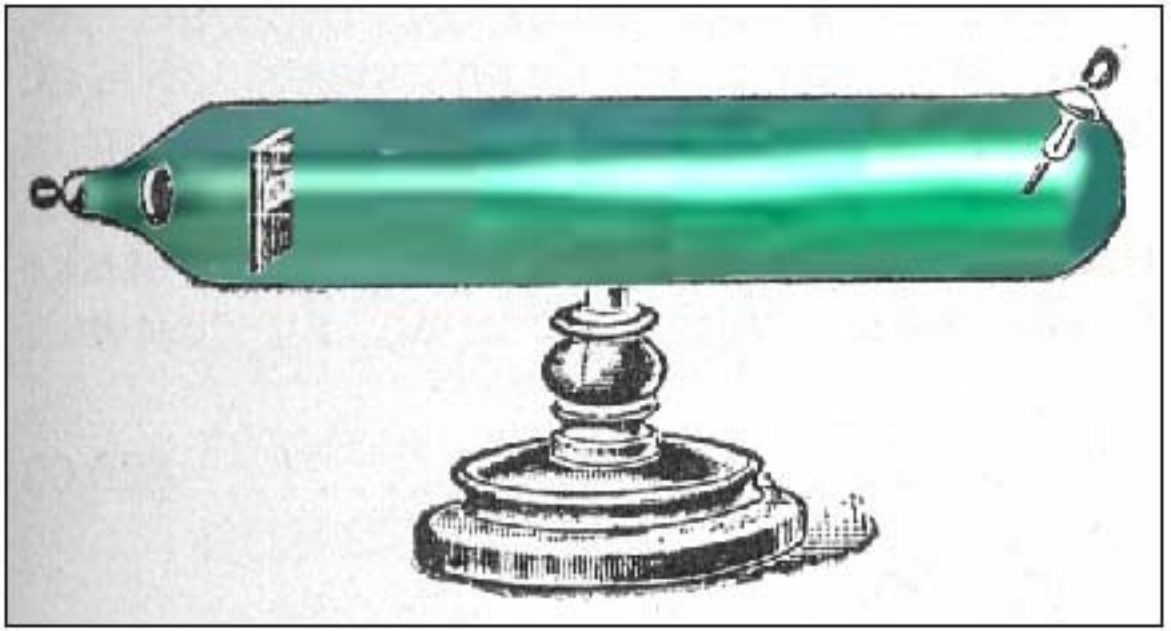

Structure of Matter

Historical Steps to the Structure of Matter

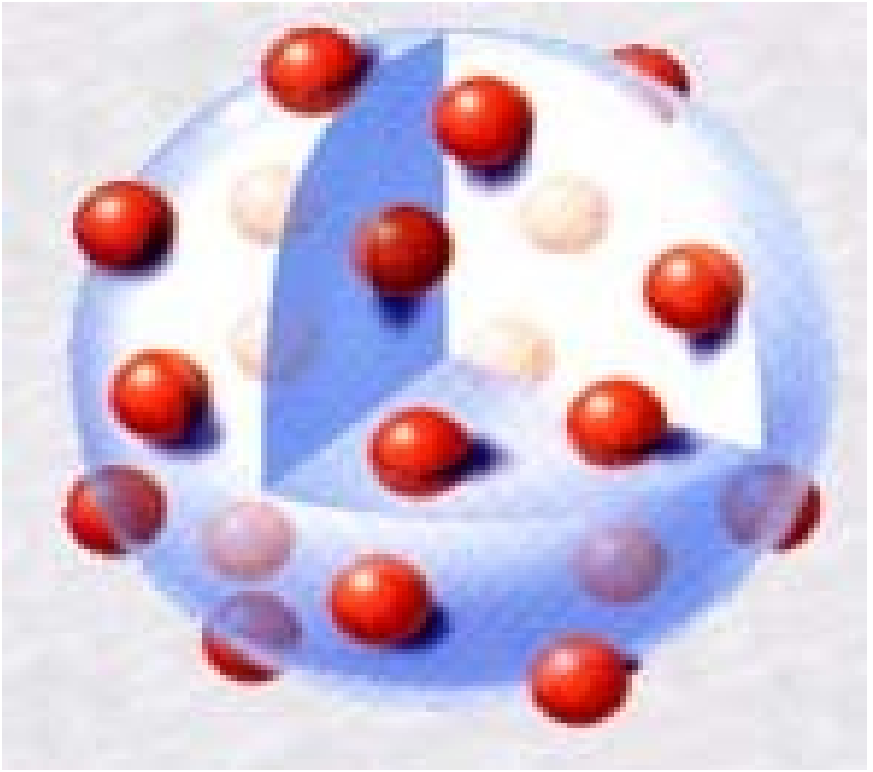
1897: J.J. Thomson discovers the electron through his experimentation of cathode rays.

Cathode Tube



Historical Steps to the Structure of Matter

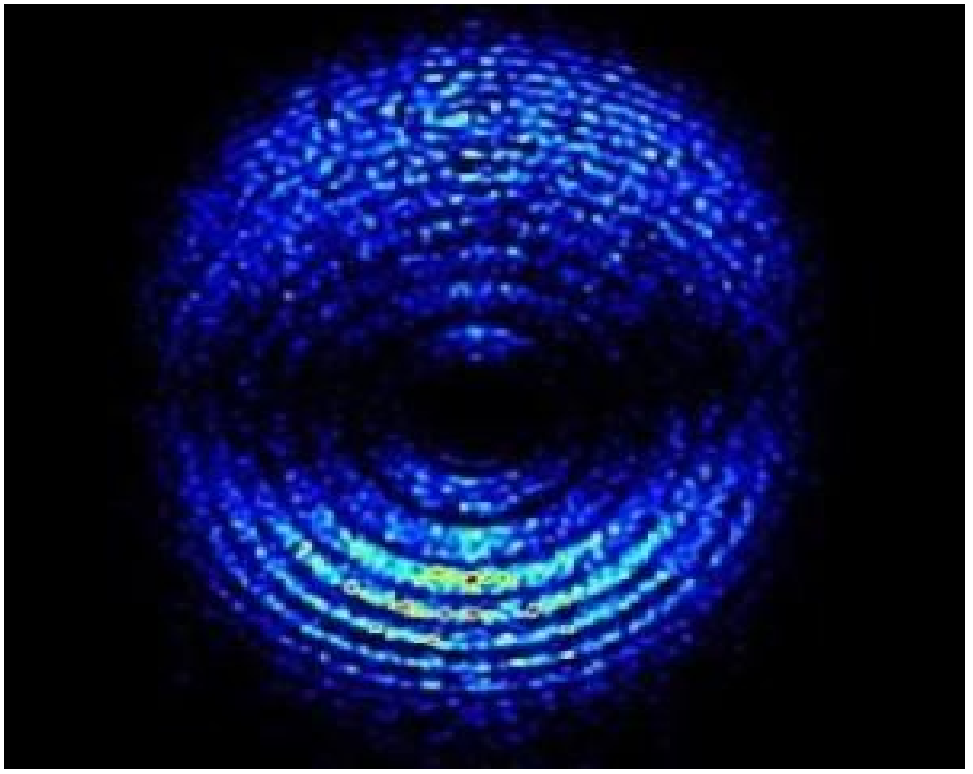
Thomson's Model of the Atom



“Thomson Pudding”
Electrons stuck in a positive paste.

Historical Steps to the Structure of Matter

Electron: subatomic particle that carries negative electric charge found in discrete energy orbits around the nucleus or moving free about a material.



Mass: $9.10938215 \times 10^{-31}$ kg

Charge:

-e

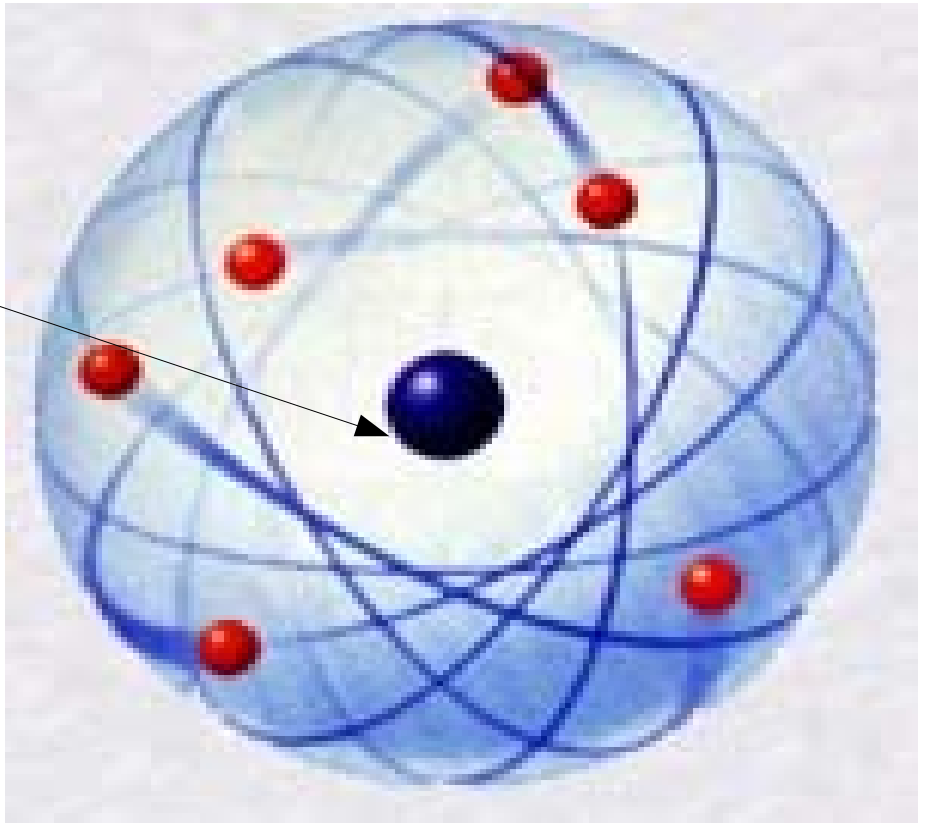
Historical Steps to the Structure of Matter

1912: Ernest Rutherford discovers the nucleus.

Proton: subatomic particle found in the nucleus of an atom with elementary charge of +1.

mass: $1.672621637 \times 10^{-27}$ kg
Charge: +e

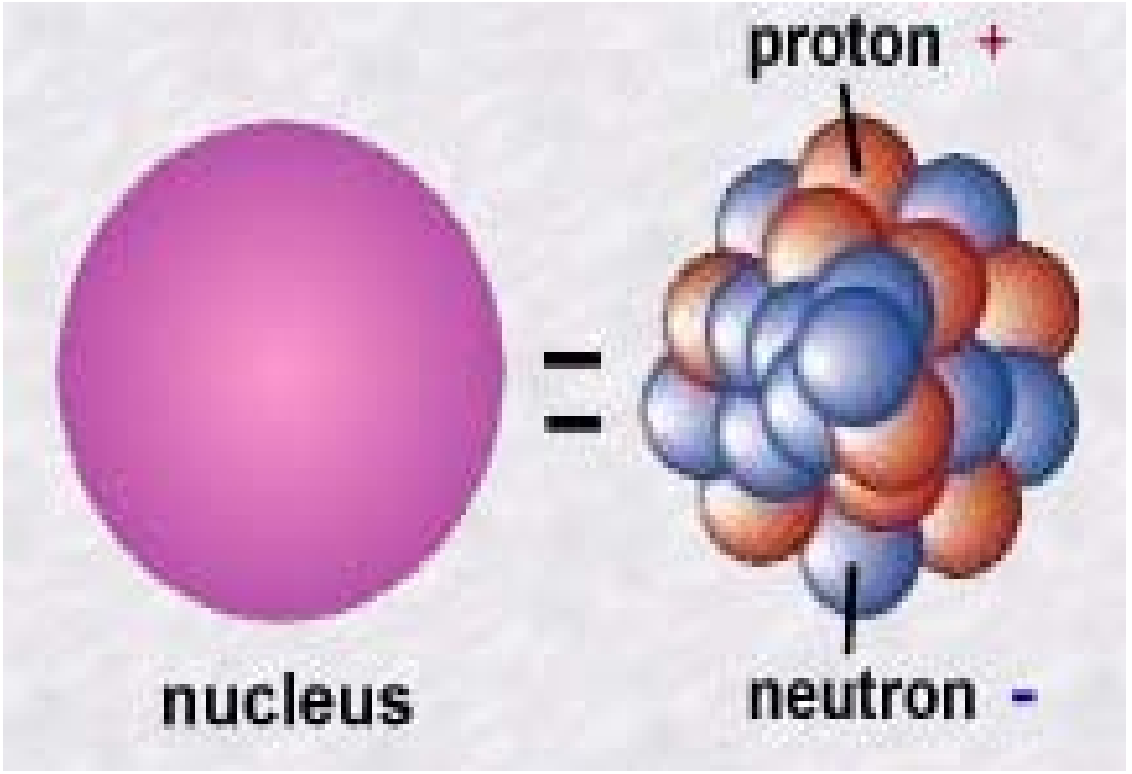
"Planetary Model":
Protons at the center with electrons orbiting the protons which uses Newton's Laws and Gravity to predict orbits of electrons.



Historical Steps to the Structure of Matter

1932: James Chadwick discovers the neutron.

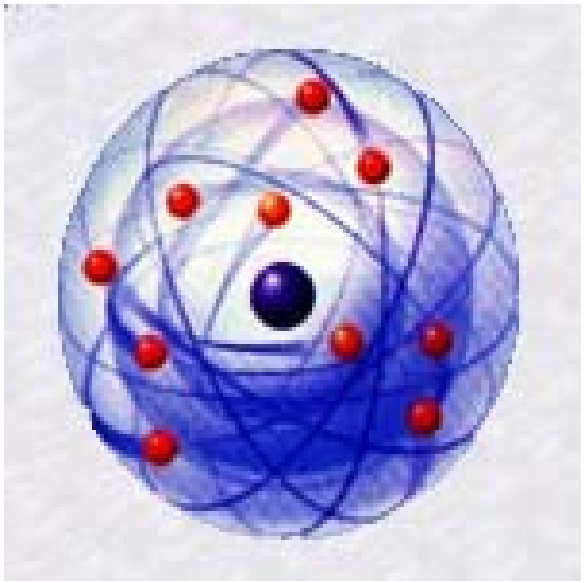
Neutron: subatomic particle with no net electrical charge found in the nucleus of an atom.

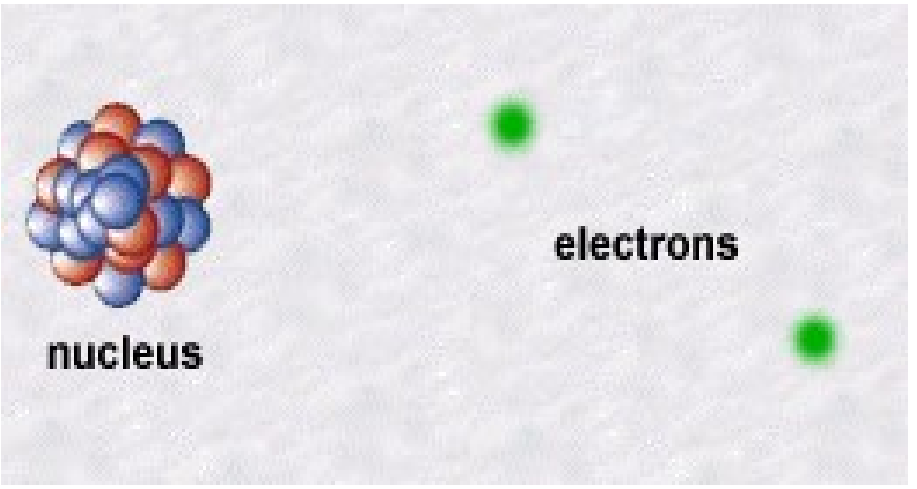


mass = $1.67492729 \times 10^{-27}$ kg

Historical Steps to the Structure of Matter

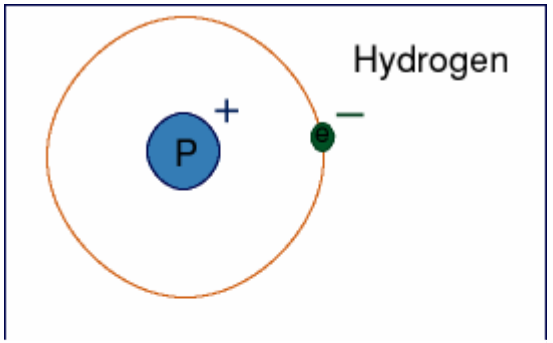
Bohr Model: created by Neils Bohr is very similar to the planetary model however does not use specifically Newtons laws to govern the motions of the electrons and only allows for discrete energy levels for electrons to orbit within.





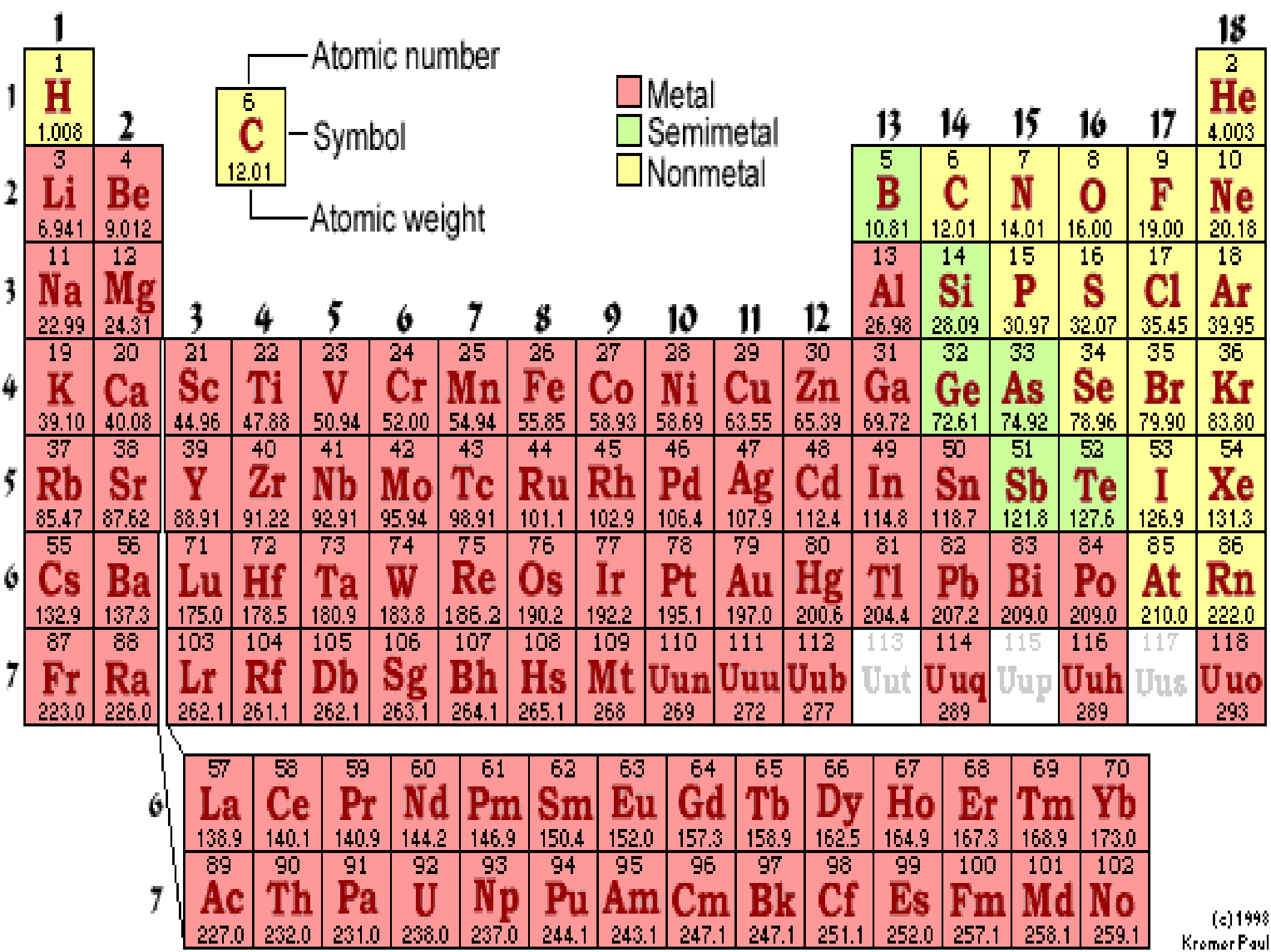
Properties

Element: determined by the unique number of protons at the center of the atoms nucleus.



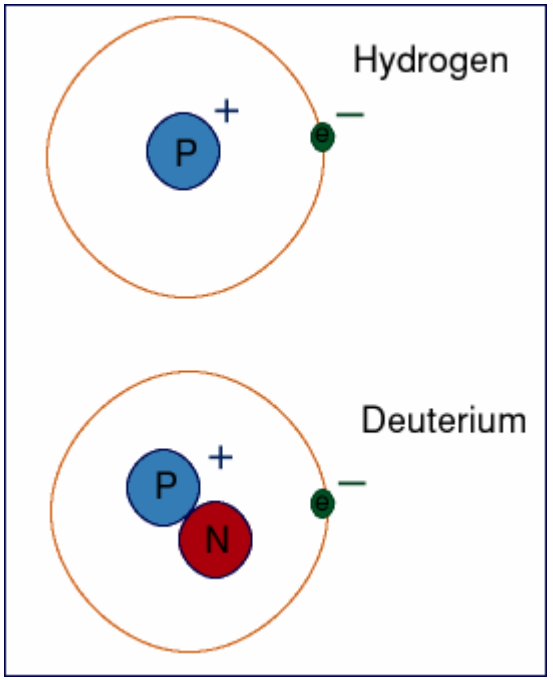
Stable atoms contain the same number of electrons as they do protons.

How many elements are there???



Properties

Roughly 92 “natural” elements. The rest are made in laboratories.



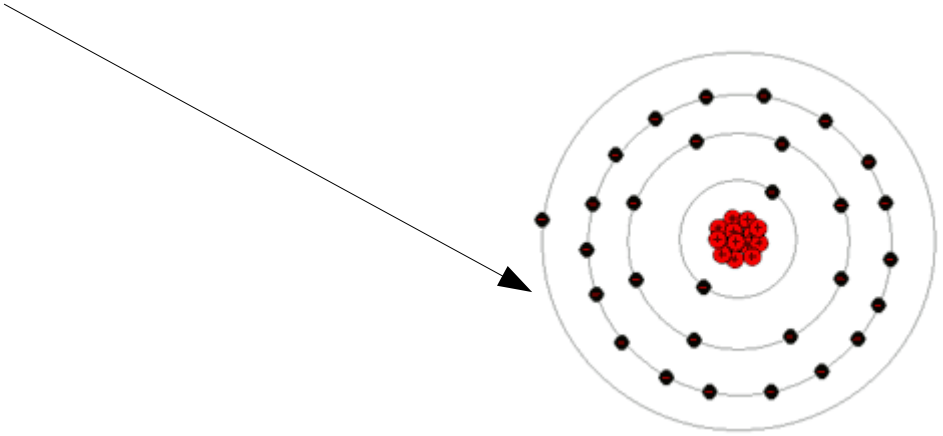
Isotopes: different types of atoms of the same chemical element that have different atomic weight due to the number of neutrons in the nucleus. (heavier versions of the same element)

Deuterium is an isotope of Hydrogen:

Atomic Weight: 1 proton + 1 neutron

Properties

Valence Shell: the outermost orbit of an atom.



1 electron in valance shell.

Atoms tend to be at their least reactive and most “stable” when the valance shell is filled with the maximum of 8 electrons.

Drawing a full model of an element

Steps:

1. Draw a circle to represent the nucleus.

2. Place the number of Protons and Neutrons in the nucleus followed by a P or N respectively.

3. Determine how many orbits there are around the nucleus.

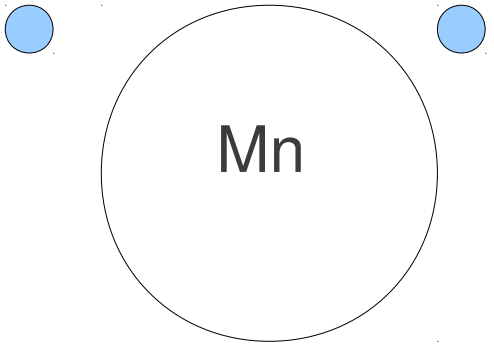
4. Draw the orbits as concentric circles around the nucleus.

5. Place the proper number of electrons in each orbit as circles with negative signs in them.

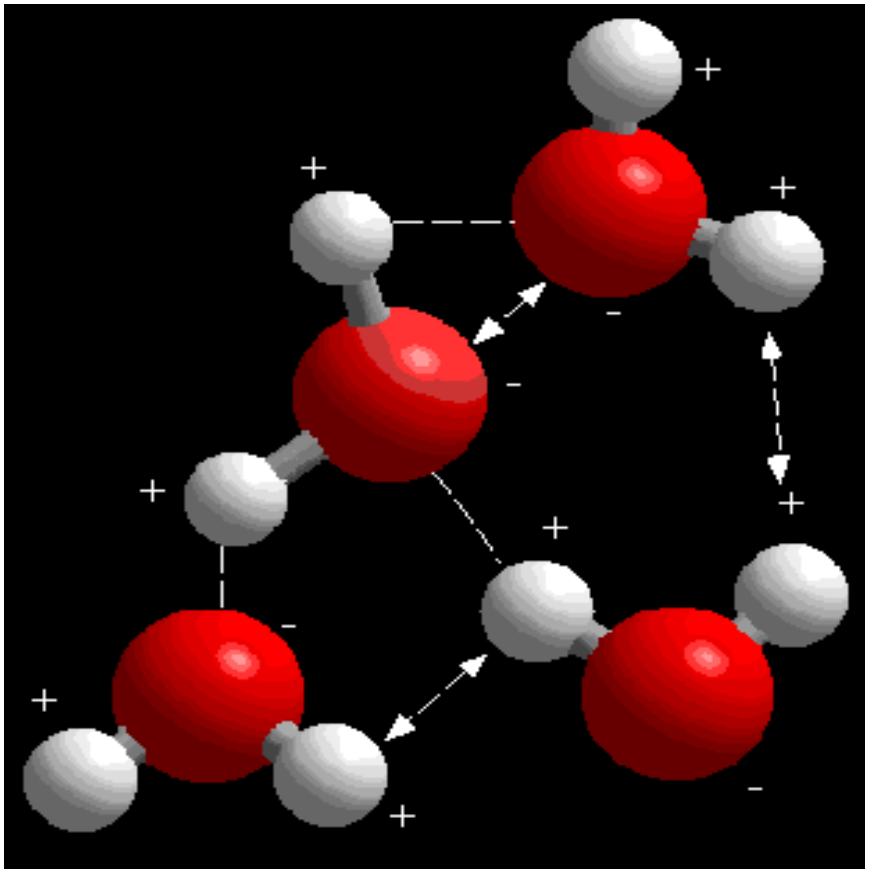
Dot Models of Elements

Steps:

1. Draw a circle to represent the element.
2. Place the symbol of the element in the center of the circle.
3. Determine the number of electrons in the valance shell.
4. Represent each valance electron as a dot around the outside of the circle.

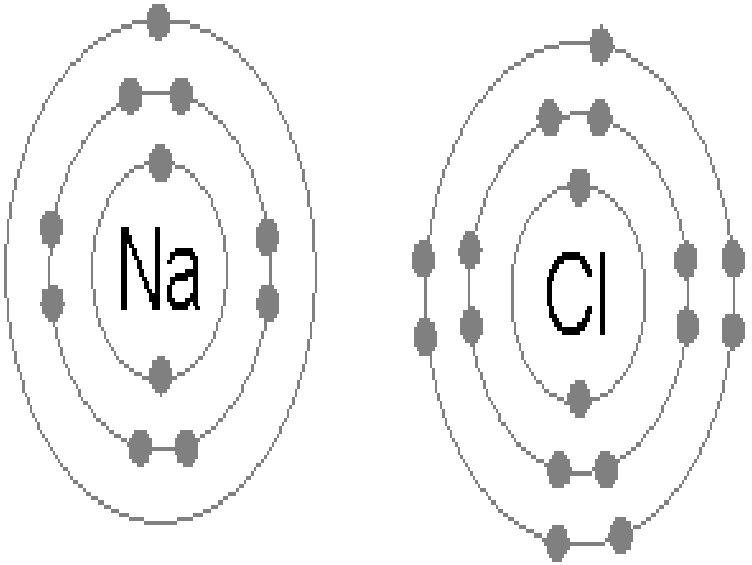


Properties



Chemical bond: physical process responsible for the attractive interactions of atoms where electrons are either shared, lost, or gained between atoms.

Two Types of Bonds:



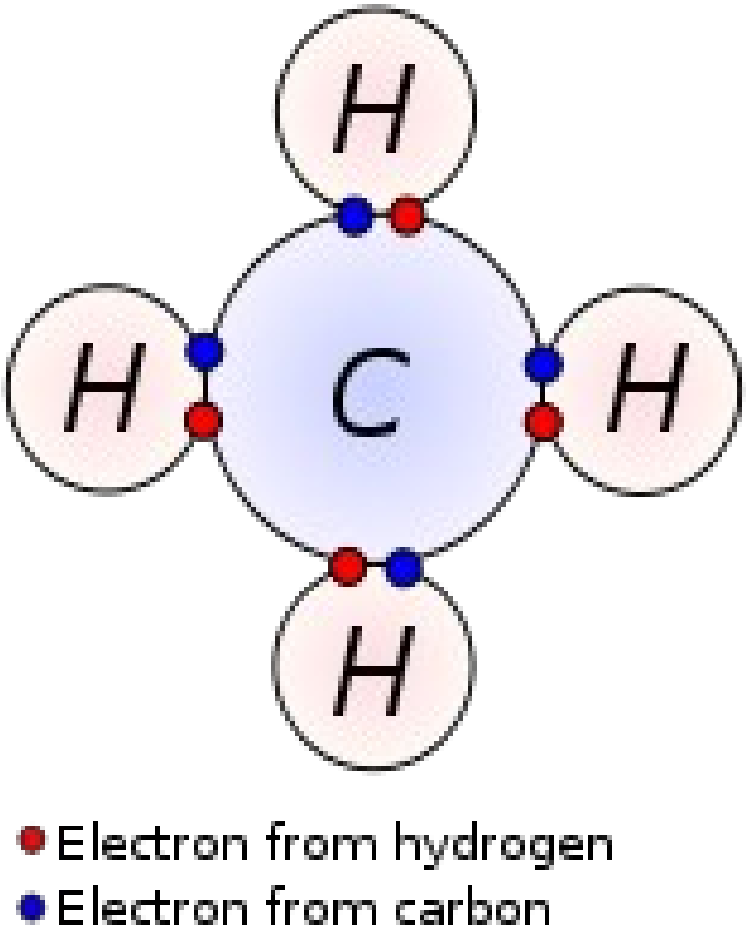
Ionic Bond:
Electrons are lost or gained in the valence shell of atoms which create one positive atom and one negative atom.

- metal-nonmetal reaction

- Dissolve in water

- Conduct electricity

Two Types of Bonds:



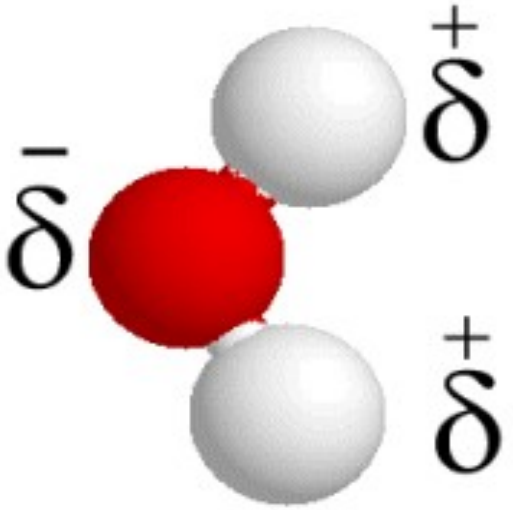
Covalent Bond:
Electrons are shared between atoms with valence orbits overlapping.

- Nonmetal-nonmetal reactions.

- Do not readily dissolve in water.

- Do not conduct electricity.

Polar Covalent Bonds and the Disassociation of water



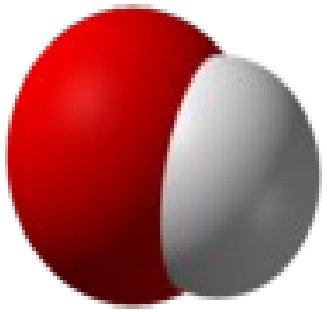
In brief moments oxygen will contain all the electrons in the molecule.

Creates a polarity on the molecule.

Oxygen becomes momentarily a little more negative.

Hydrogens become positive.

This can create an opposing polarity for the two hydrogen and one may become disassociated form the molecule to form two new compounds.



Hydroxide Ion
[OH-] = 1 x 10^{-7}

Hydrogen Ion
[H+] = 1 x 10^{-7}

Acids and Bases

Neutral:

Ratio of hydroxide ions (OH-) and hydrogen ions (H+) are one to one. $1 \times 10^{-7} = 1 \times 10^{-7}$

Acid:

Ionic compounds that break apart in water to alter the ratio of OH- and H+ in the solution to have more H+.

HCL is an acid

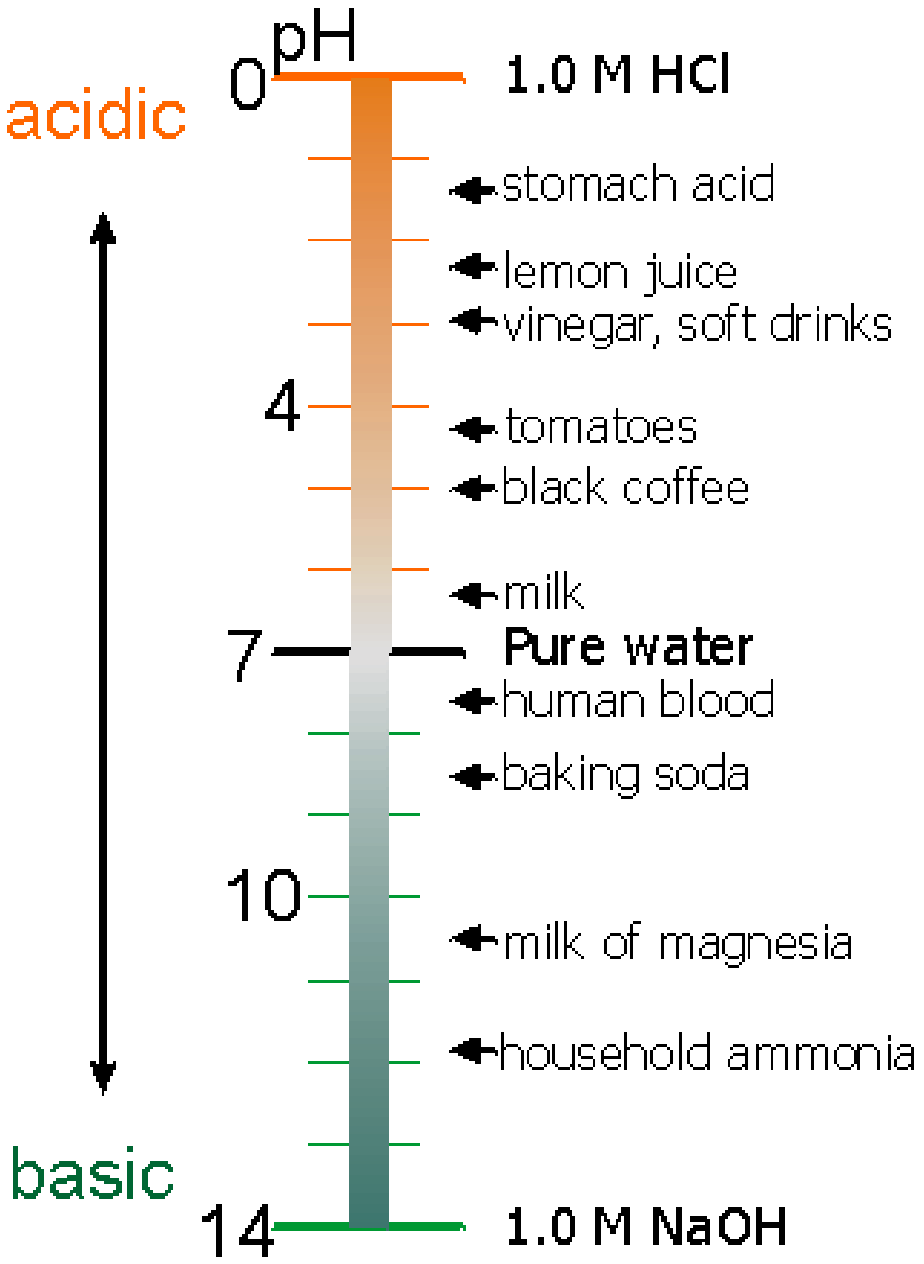
$H+ > OH-$

Base:

Substance that accepts hydrogen ions. When dissolved in water the ratio of OH- and H+ in the solution is altered to have less H+.

$H+ < OH-$

NaOH is a base



pH scale represents the concentration of Hydrogen Ion in a substance [H+]

Water has a concentration of 1×10^{-7} [H+]

Therefore the pH of water is 7.

The numbers on the scale represent the negative exponent on the concentration.

Also use to find OH- concentration by subtracting the pH value from 14.

Particle Accelerators

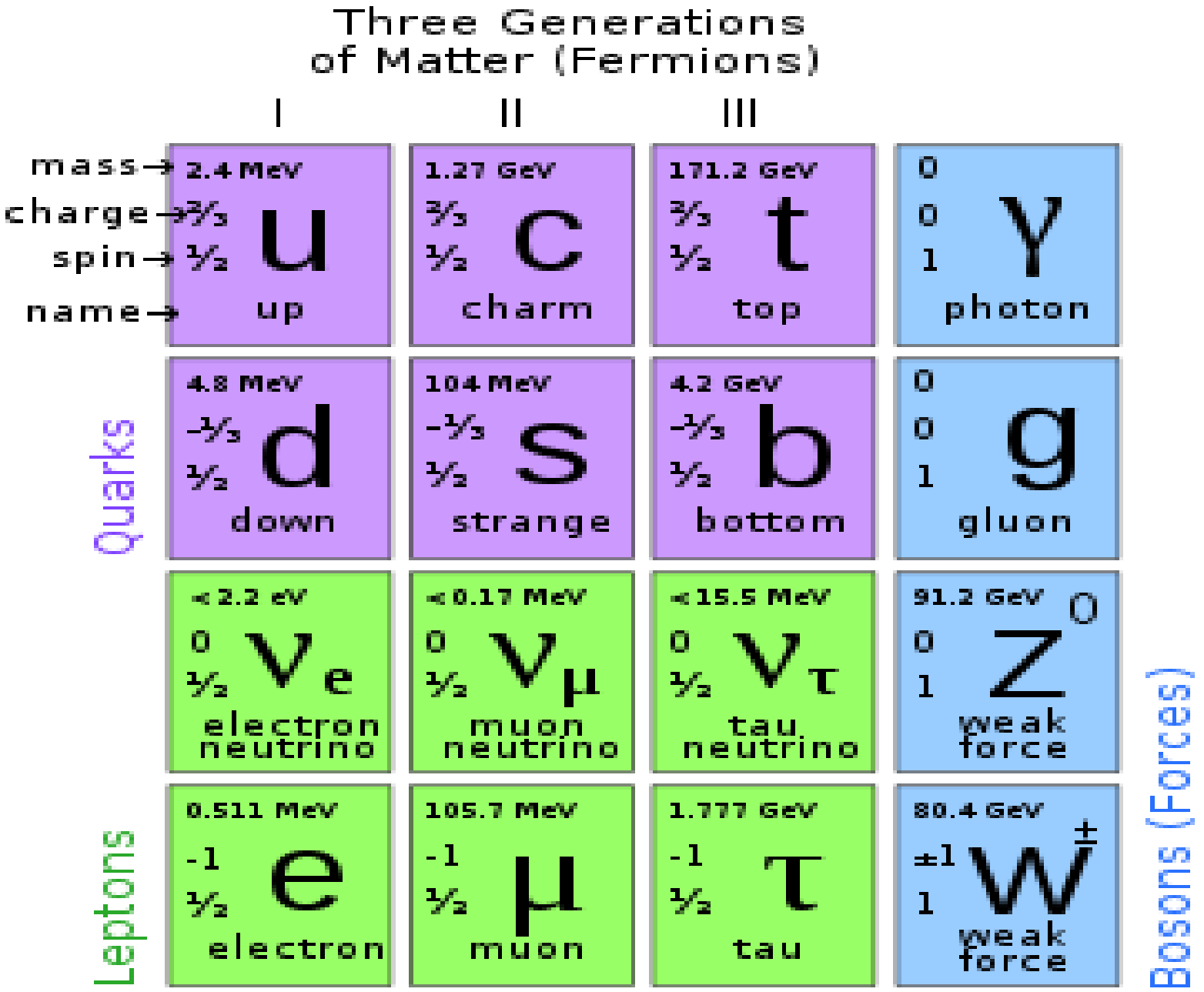
Historical Steps to the Structure of Matter

Standard Model: theory of the four known fundamental interactions and the elementary particles that take part in these interactions.

Elementary particles: a particle not known to have any substructures.

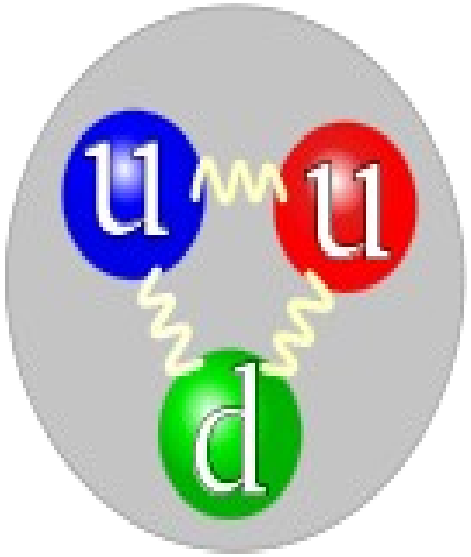
Quarks, Leptons, and Gauge Bosons

Elementary Particles

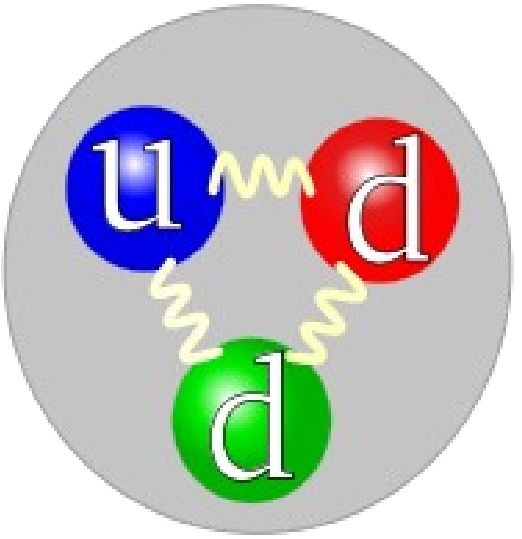


Elementary Particles

Quarks: elementary particle that is a major constituent of matter that is found to make up protons and neutrons and is the only elementary particle to experience all four fundamental interactions.



Proton: comprised of 2 up and one down quarks.



Neutron: comprised of 2 down and one up quarks.

Elementary Particles

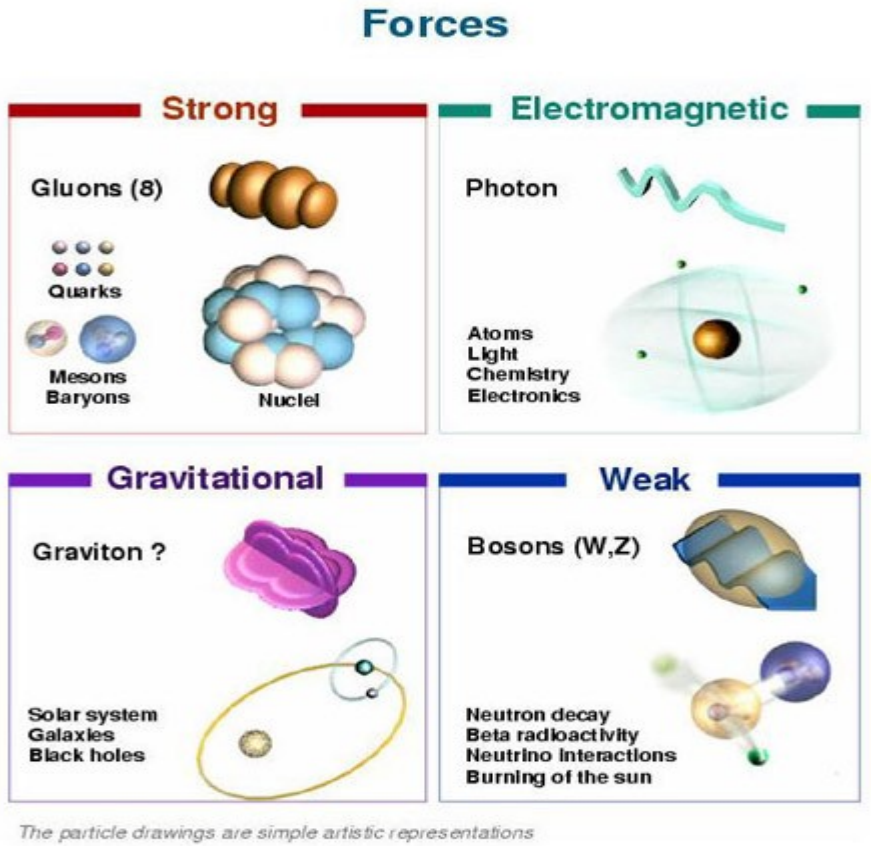
Leptons: a family of elementary particles that includes the electron, the muon, and the tau as well as their neutrino counterparts.

Leptons are subject to all the fundamental forces except the strong nuclear force.

Elementary Particles

Gauge Bosons: particles that act as carriers of the fundamental forces of nature.

Fundamental Force	Carriers
Strong	gluons
Electromagnetic	photons
Weak	W and Z bosons
Gravitation	graviton (?)



awwww...Look puppies!!!!!

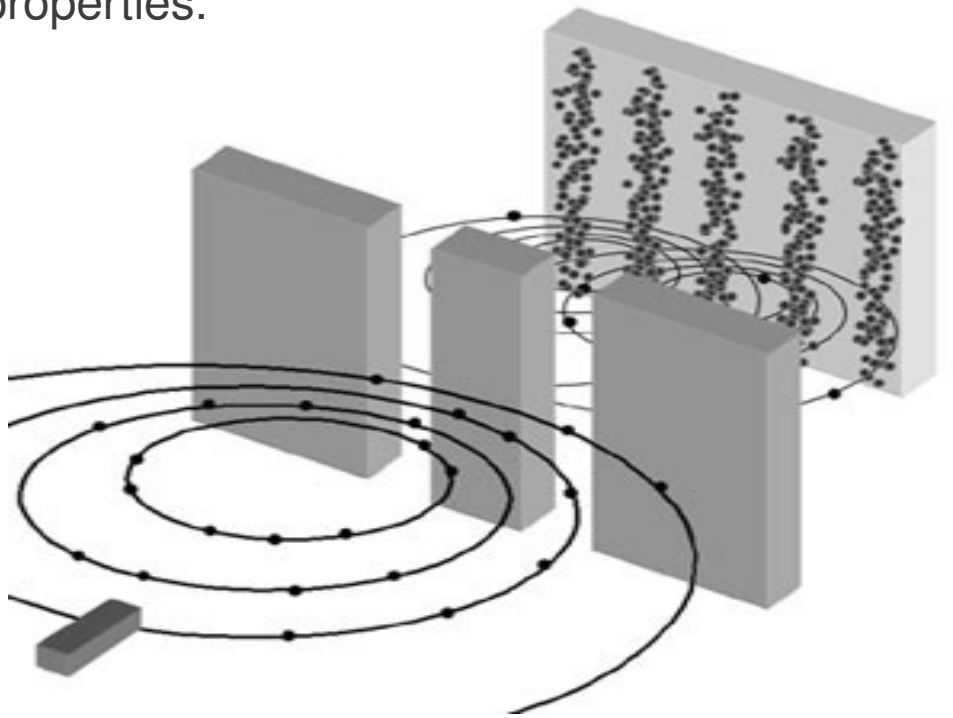
Things get even weirder: Quantum Mechanics/Theory

Quantum Theory- theoretical basis of modern physics that explains the nature and behavior of matter and energy on an atomic and subatomic level.

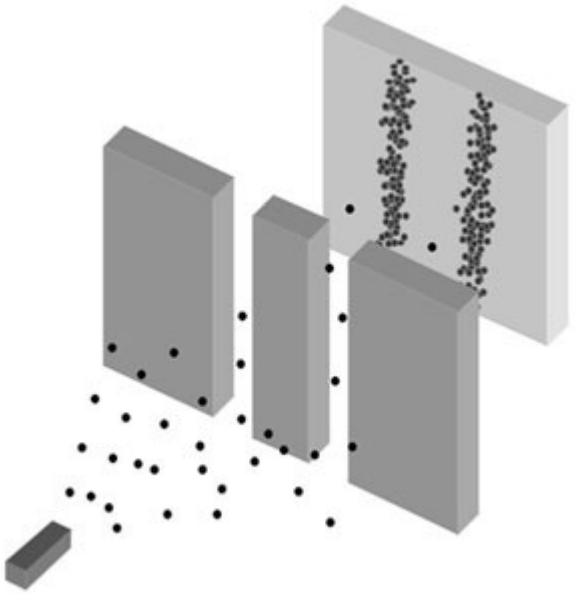
“Quanta”- a discrete amount of “something”.

Central Concept of Quantum Theory

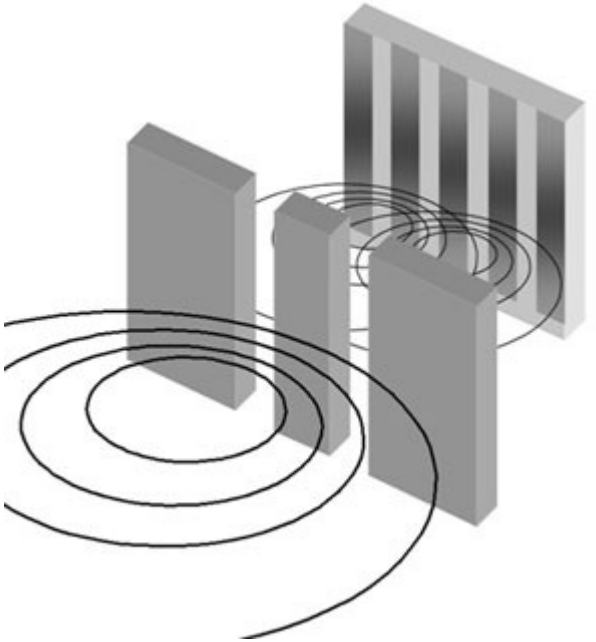
Wave-Particle Duality: concept that all matter and energy exhibits both wave-like and particle-like properties.



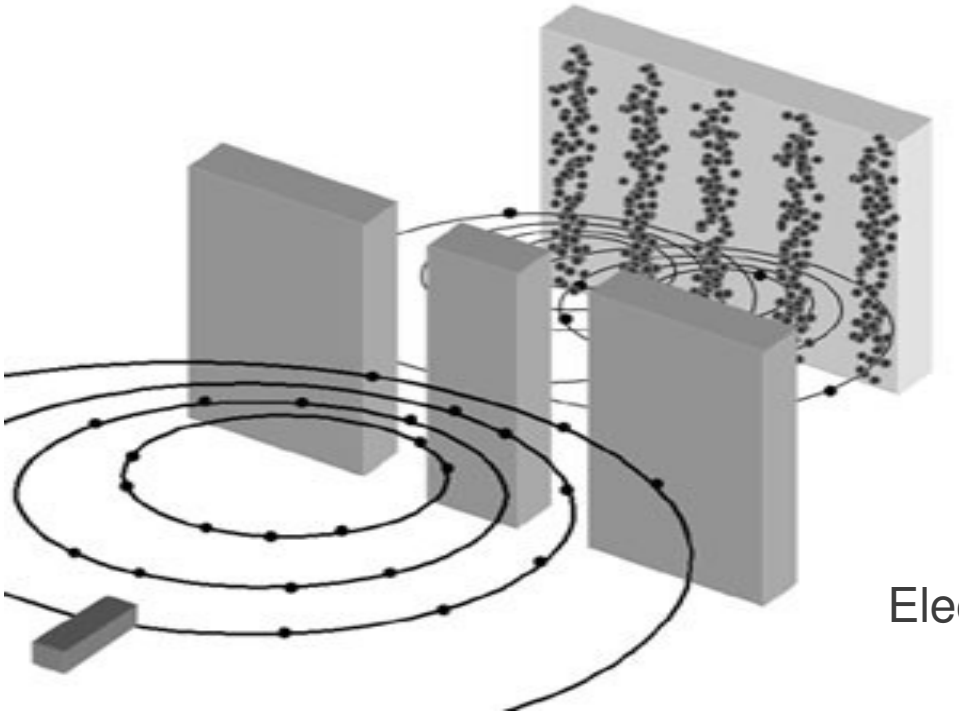
Wave- Particle Duality



Particle

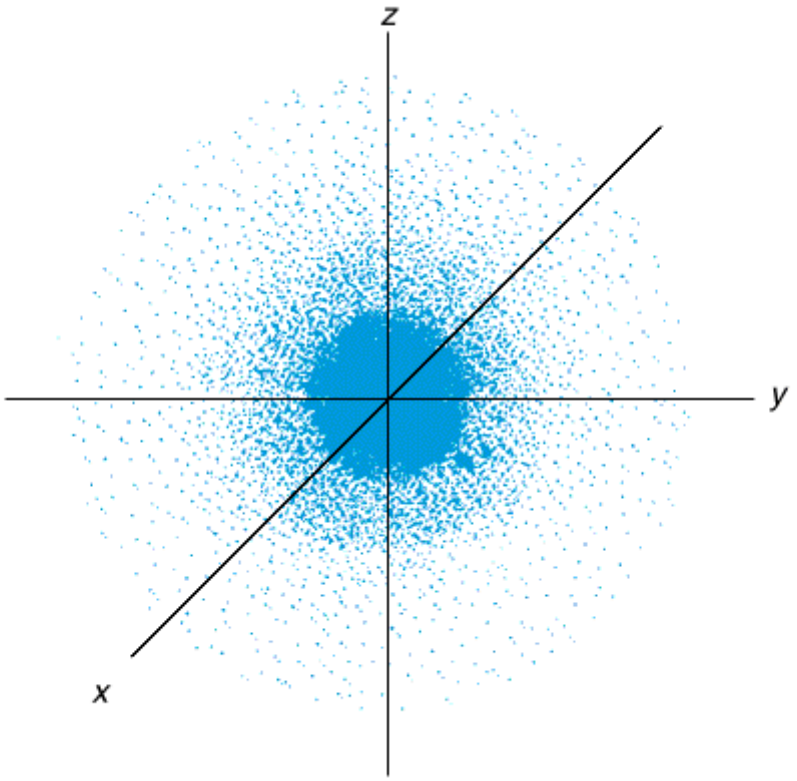


Wave



Electron

Things get even weirder: Quantum Mechanics



Electrons in orbit around nucleus given the uncertainty principle.