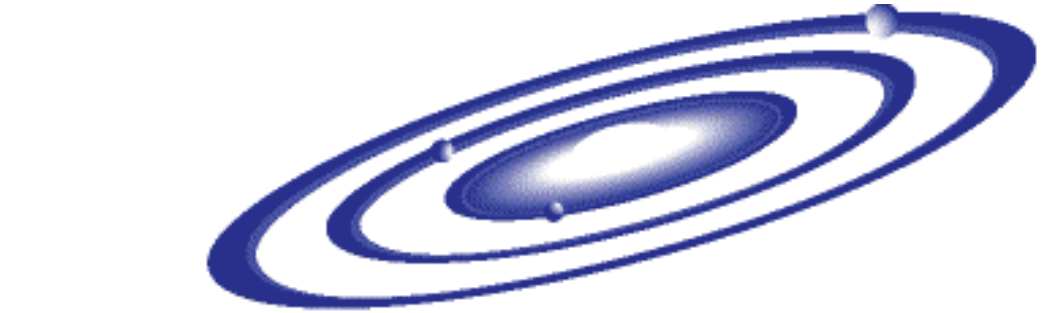

Cosmic Chemistry:
An Elemental Question

Name of Presenter

Presenter Job Title

Cosmic Chemistry: An Elemental Question

An atom is the basic structure from which all matter is composed, in the same manner as a brick is basic to the structure of a wall. Although atoms are too small to be seen with our eyes, scientists have long had indirect evidence for the existence of atoms.

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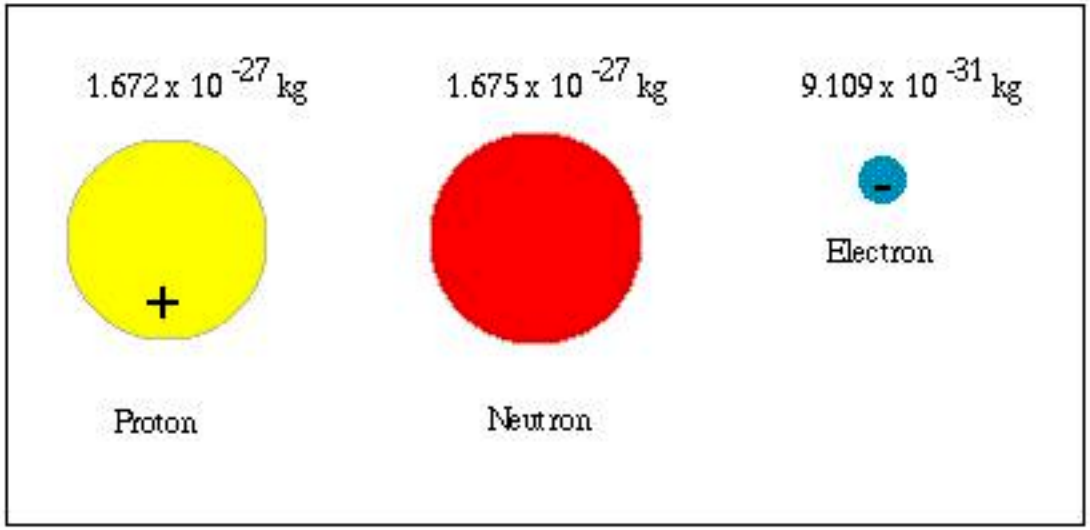

Model of Proton, Neutron, and Electron

Atoms are made of small particles called protons, neutrons, and electrons. Each of these particles is described in terms of measurable properties, including mass and charge. Mass is the amount of matter that an object contains. The proton and neutron have roughly the same mass and have approximately one thousand times the mass of the electron. The proton and electron have equal, but opposite, electrical charges. A neutron does not have an electrical charge.

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If the proton and neutron were enlarged, and each had the approximate mass of a hippopotamus, the electron, enlarged to the same scale, would have less mass than an owl.

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Most of an atom is empty space. The nucleus of the atom contains almost all of the mass of the atom. A greatly enlarged atom might look like a marble (the nucleus) inside an empty football stadium. (The electron probability cloud is where the electron is likely to be).

Electron Probability Cloud Around a Nucleus

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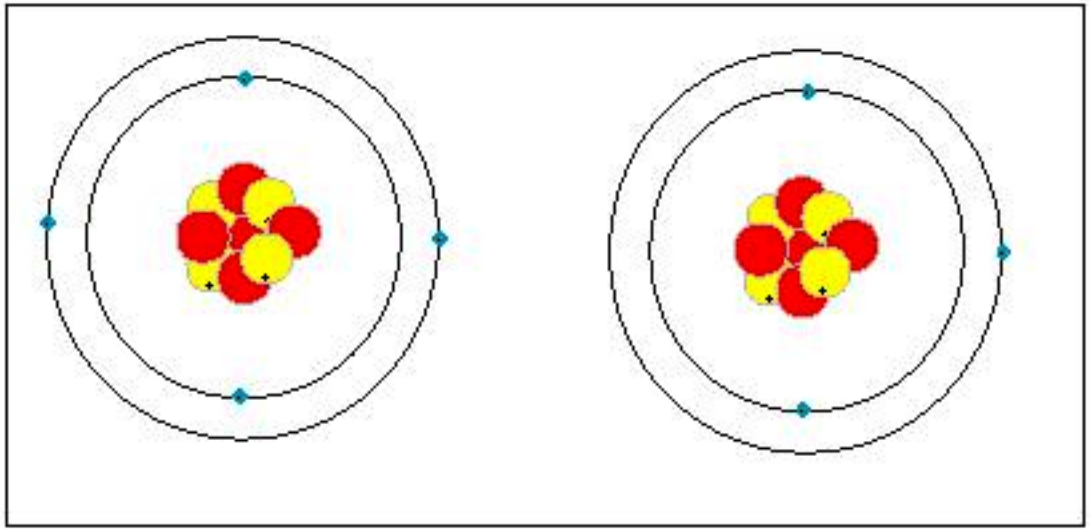

Diagram Comparing a Beryllium Atom and a Positively-Charged Beryllium Ion

The attractive electric force between the positively-charged protons in the nucleus and the negatively-charged electrons around the nucleus holds the atom together. Atoms containing the same number of protons and electrons have no net charge. Atoms that have extra electrons or are missing electrons have a net electrical charge and are called ions. Ions can interact with other ions due to the electrical attraction between opposite charges.

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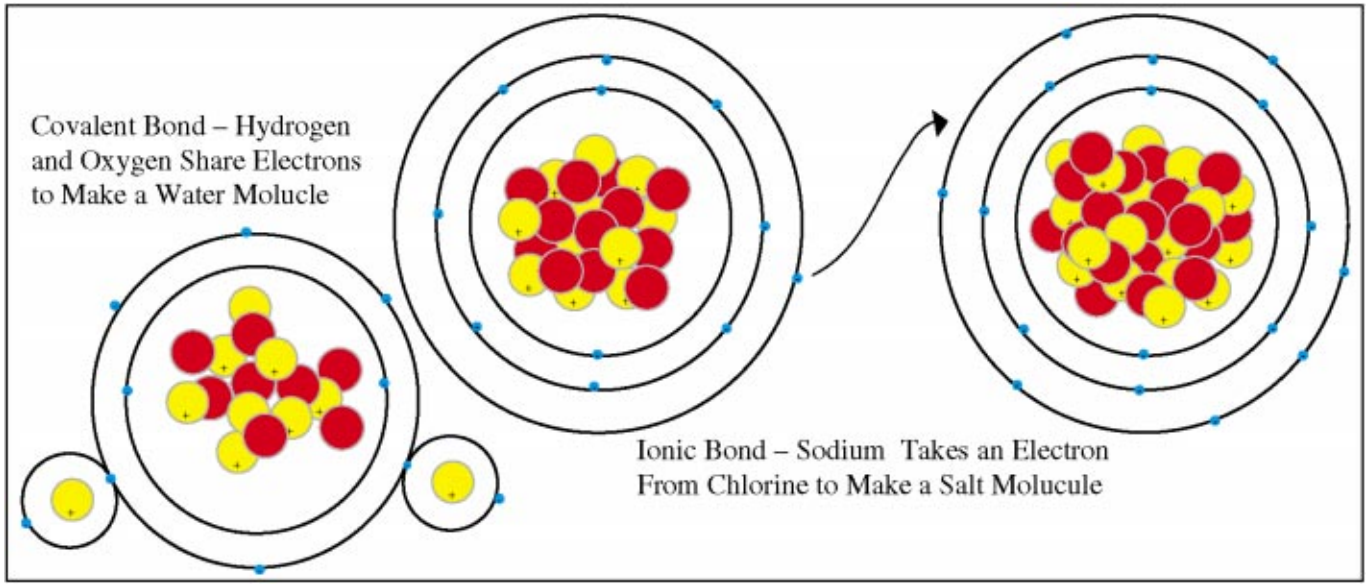

Model of Covalent and Ionic Bonds

Atoms interact with other atoms by sharing or transferring electrons that are farthest from the nucleus. These outer electrons determine the chemical properties of the element, such as how readily it interacts with other elements and the allowable ratios for its combinations with other substances.

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Element	Symbol	Relative % of Earth's Mass
Oxygen	O	46.6
Silicon	Si	27.7
Aluminum	Al	8.1
Iron	Fe	5.0
Calcium	Ca	3.6
Sodium	Na	2.8
Potassium	K	2.6
Magnesium	Mg	2.1
Titanium	Ti	0.4
Hydrogen	H	0.1

An element is a substance made up of a single type of atom. It can't be broken into simpler components by chemical processes. There are 92 naturally occurring elements. They may be solids, liquids, or gases. The elements are distributed unevenly, with some much more common than others. The ten most abundant elements on earth make up more than 96% of our planet.

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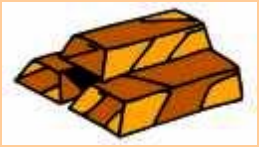
Gold is one example of an element.



A bar of gold can be shaved into gold dust, and still be recognizable as gold.

How fine can the dust become and still be considered gold?

The smallest particle that would still have the properties associated with gold is an atom. How small is an atom? Consider that a small gold coin may contain over 20,000,000,000,000,000,000,000 atoms.

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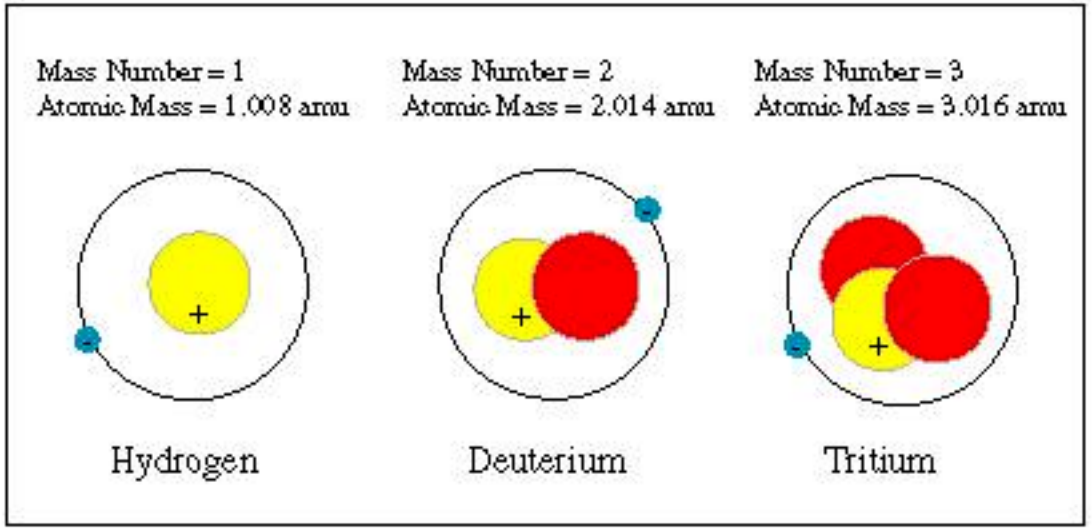

Diagram Comparing Hydrogen, Deuterium, and Tritium Atoms

Atomic mass values for elements are almost never an integer. The mass of an atom of an element in amus is the ratio of its mass to the mass of a carbon-12 atom. Even the masses of protons, neutrons, and electrons are ratios of their mass to carbon-12. These ratios are not integers. Since atoms are made of various numbers of these particles, it is unlikely that the mass of an atom other than carbon-12 would add up to exactly a whole number.

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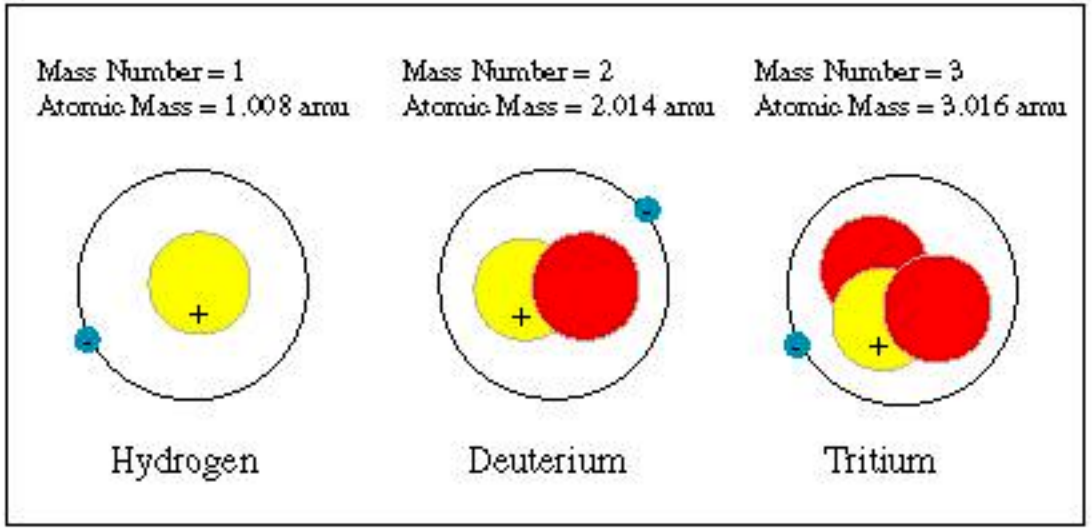

Mass Number and Atomic Mass of Hydrogen, Deuterium, and Tritium Atoms

Most atoms of the element hydrogen contain only one proton in their nuclei. Each of these atoms has a mass of 1.008 amu. There exist atoms of hydrogen that have either one or two neutrons in the nucleus in addition to the single proton. These are called deuterium or tritium, having masses of 2.014 amu and 3.016 amu respectively.

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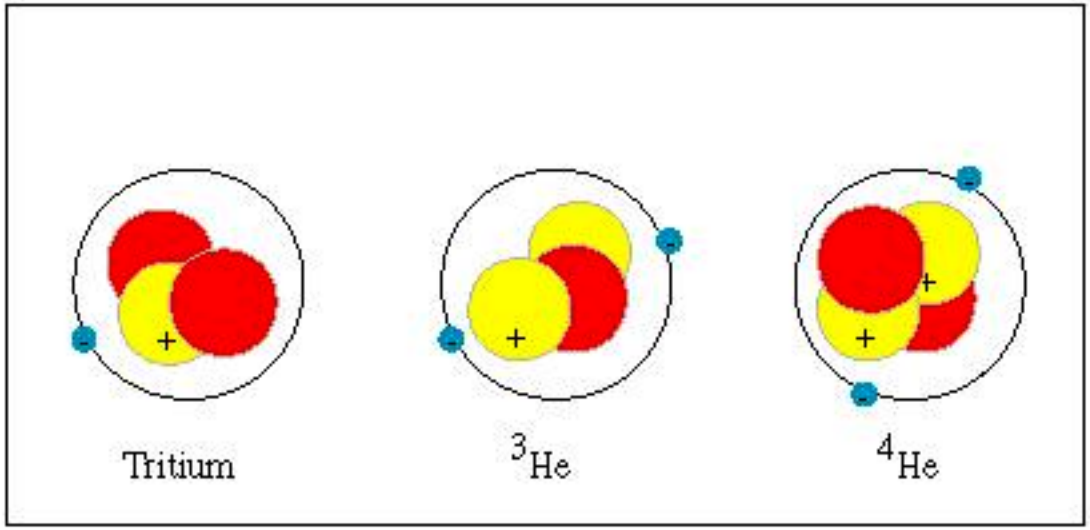

Diagram of Tritium, ^{3}He, and ^{4}He Atoms

What would we call an atom that had three particles in its nucleus, like tritium, but two were protons and one was a neutron? This would be an uncommon isotope of a different element, helium (He3). The most common isotope of helium (He4) has two protons and two neutrons in the nucleus of each atom.

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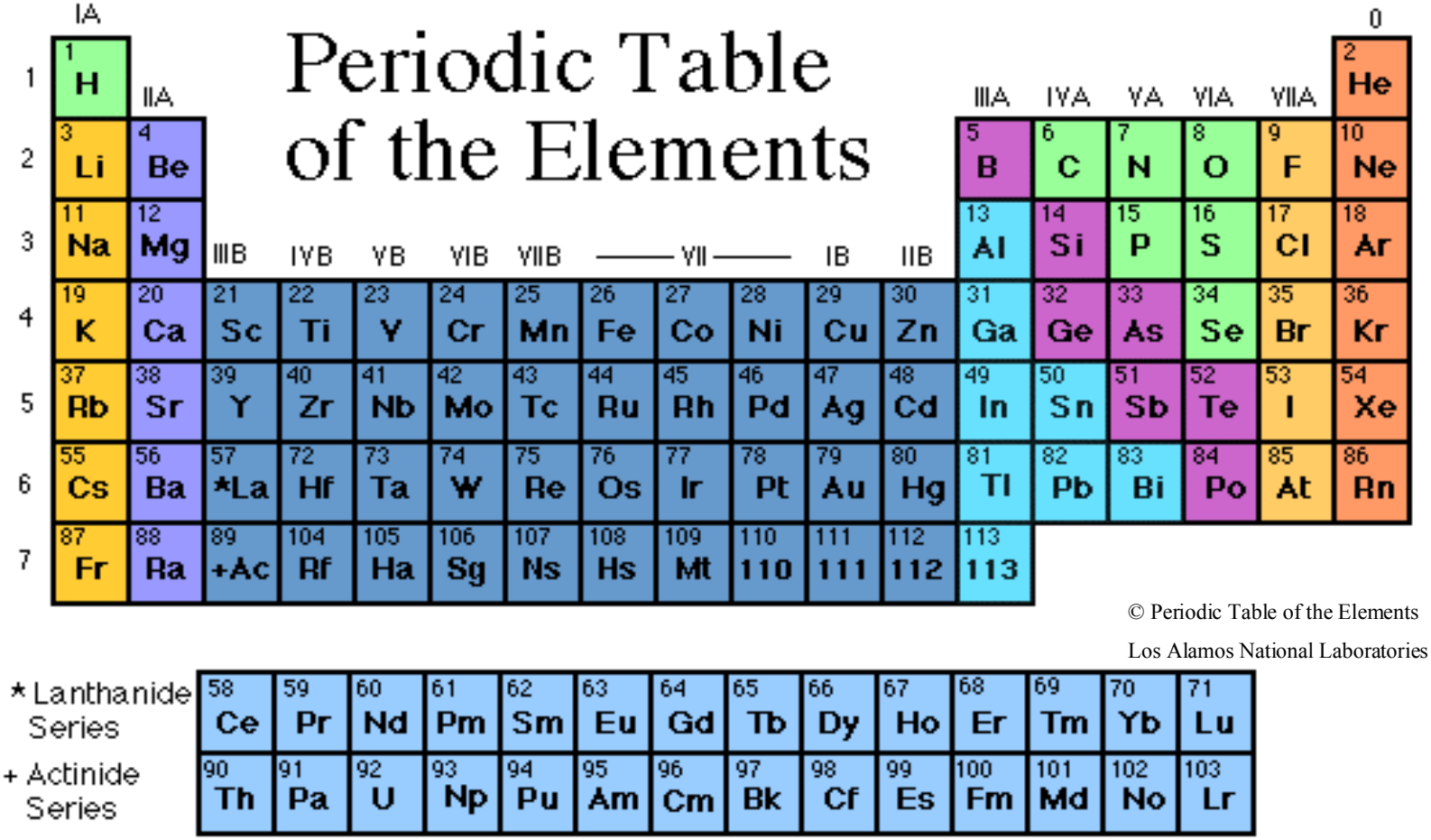

There are 92 elements found in nature and several more exotic, manmade elements. Based on their chemical and physical properties, scientists have invented a tool to show relationships among these elements. It is called the periodic table of the elements.