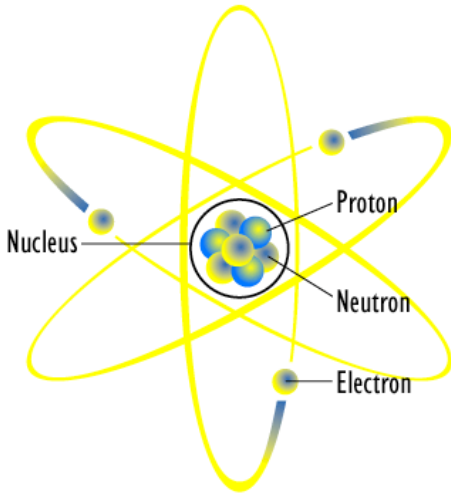
What are atoms?

Everything around you is made of atoms: the air you breathe, your body, this book you are holding. You cannot see atoms, though, because they are so small. Different types of atoms make up the different items around you. For example, hydrogen and oxygen atoms make up water. Other atoms that you may have heard of are silver, gold, or iron atoms.

Atoms are the building blocks of nature, but they are made of even smaller things called protons, neutrons, and electrons. An atom has protons and neutrons in the middle part, called a nucleus, with electrons flying around outside the nucleus. The part outside the nucleus, where the electrons are, is called the electron cloud. The number of electrons in the cloud is the same as the number of protons in the nucleus. Atoms with the same number of protons are called elements. For example, all gold atoms have 79 protons, but could have any number of neutrons. Sometimes you will see a number after the atom's name: this tells you the total number of neutrons and protons in the nucleus. For instance, gold-197 has 79 protons and 118 neutrons in the nucleus.

In your body alone there are over 10,000,000,000,000,000,000,000,000 atoms!

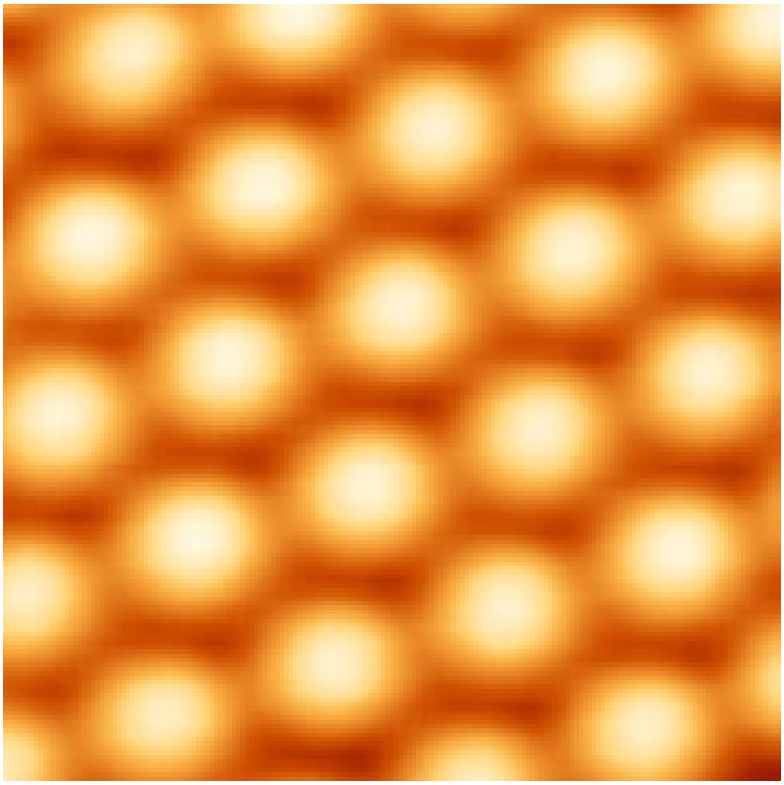


This is an atom: it has a nucleus of protons and neutrons surrounded by electrons.

Scientists have thought that atoms make up everything for thousands of years but have not been able to see them with a microscope until recently. Even when scientists take pictures of atoms, they cannot see past the electron cloud. This makes the atoms look like circles in a picture.

Protons and electrons have what is called a charge. These charges are responsible for electricity.

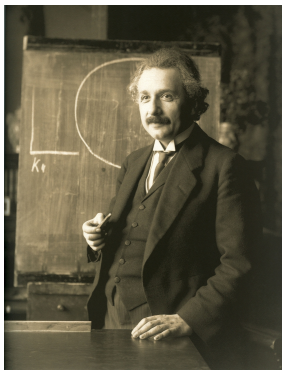
Over 2000 years ago, the ancient Greek philosopher Democritus thought that all matter was made of a basic building block he called atoms.



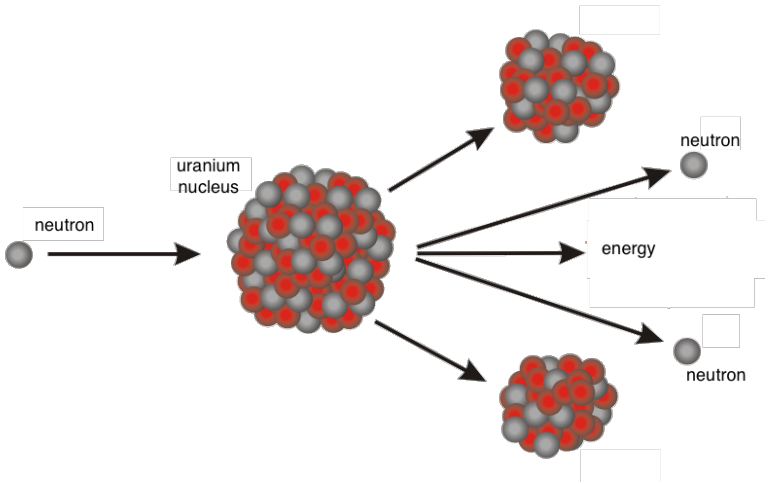
This is a picture of atoms of the element silicon using a scanning tunneling microscope.

Nuclear power

Radiation can be used to create electricity. When it is hit by a neutron, the nucleus of a uranium atom can split and create other atoms. This splitting is called fission. When uranium atoms split, they release lots of energy. This energy is called nuclear energy because it comes from the nucleus of an atom. Nuclear power plants turn this energy into heat inside a nuclear reactor. The nuclear reactor is usually inside a tank of water that heats up and creates steam. This steam then is turned into electricity by spinning large machines called turbines. The steam is sometimes released in large towers. About one out of every five houses in the United States gets its electricity from a nuclear power plant.



Albert Einstein's theory of relativity gave us the formula $E = mc^2$. This equation tells us that mass can be turned into energy. This is what happens in a fission reaction: some of the mass in the uranium nucleus turns to energy.



When a neutron hits a uranium nucleus, the nucleus can split into two. This fission reaction releases more neutrons and energy.

This drawing shows the creation of the first man-made nuclear reactor in 1942, when scientists stacked uranium and carbon blocks to create a fission chain reaction.

When the uranium atom splits, the neutrons that it releases can then go on and cause other uranium atoms to split. This creates what is called a chain reaction because each time a uranium atom splits, the neutrons released can cause another atom to split.

Nuclear power plants require much less fuel than power plants that burn fossil fuels like coal or natural gas. A coal power plant needs to burn many train cars of coal a day. The fuel a nuclear power plant uses per year could fit inside your bedroom. Nuclear power plants do not create smoke or other air pollution and are considered to be very clean. Nuclear power does produce radiation, but it actually produces less radiation than energy produced from coal power plants. When coal is burned, there are radioactive atoms in the coal that go out of the plant as smoke.

This gray metal is uranium. When made into nuclear fuel, it can power a nuclear reactor.

Here is a nuclear power plant in Germany. The white dome is where the uranium atoms are split inside the nuclear reactor. The large towers release steam created when the heat of the reactor boils water.

This worker is inspecting a bundle of nuclear reactor fuel before it is installed in a reactor. When placed inside a reactor with several other bundles, the fission chain reaction will take place. The yellow-colored material is the uranium and the gray metal holds the fuel in place.

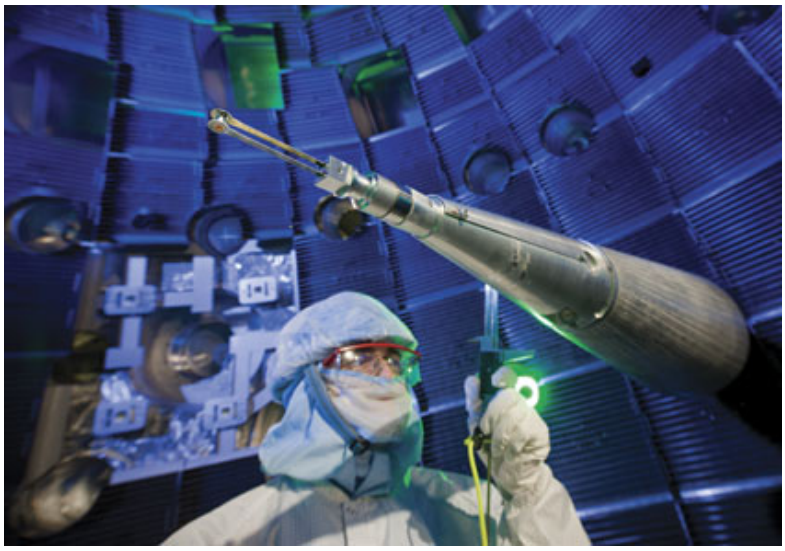
These are eight of the sixteen containers that hold all of the waste created by the Yankee Rowe nuclear power plant in Massachusetts over its 32 years of operation. During that time the power plant produced 44 billion kilowatt-hours of electricity. That is as much energy as 1,400,000,000 gallons of gasoline, or 195,000 train cars of coal. That many train cars would stretch from Washington, D.C. to Las Vegas.

The future of radiation

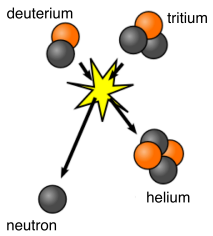
Radiation has many important uses. Every year, scientists and engineers discover more uses of radiation. Currently, scientists are developing nuclear fusion that slams atoms into each other to produce energy. The slamming together of atoms creates a new, bigger atom. This is how the sun creates energy. The only fuel needed for fusion reactions, hydrogen, can be found in the water of the ocean. If people can do fusion on Earth efficiently, there may be an unlimited supply of energy and electricity.

Other new uses of radiation are being discovered all the time. Maybe you will be the scientist to discover a new use of radiation.

The sun is a giant nuclear reactor powered by fusion energy.



Scientists are building nuclear fusion reactors like the National Ignition Facility to slam atoms together to create energy, just like the sun does. In this reactor a giant laser heats up atoms to temperatures hotter than the sun.



When hydrogen-2 (deuterium) hits hydrogen-3 (tritium), they can create helium and a neutron and release energy. Helium is the atom that makes balloons rise.