

The Standard Model



Summary

<http://quantumspotacademy.org/videos/the-standard-model/>

Natural philosophers in antiquity believed that everything is composed of earth, air, fire, and water. In the 1800s atomic theory was developed and in 1869 Mendeleev created the first periodic table of the elements, which grew to contain over a hundred elements. The next revolution occurred when physicists discovered that all atoms are composed of three particles: protons, neutrons, and electrons.

In 1936, a new particle, now called a muon, was discovered. By 1960, particle accelerator experiments revealed over a hundred new particles, and even more continued to be identified. Just as the periodic table of the elements could be explained by just protons, neutrons, and electrons, the entire zoo of exotic particles could be explained by a theory that we now call the Standard Model.

In the Standard Model, all particles are either fermions (matter particles) or bosons (force particles). The fermions are divided into two categories: quarks and leptons. The quarks are called up, down, charm, strange, top, and bottom. The leptons are called electron, electron neutrino, muon, muon neutrino, tau, and tau neutrino.

The most familiar boson is the photon, which acts as the carrier of the electromagnetic force. The gluon is the carrier of the strong force, which binds quarks together. The W and Z bosons are the carriers of the weak force, which mediates the transformation of one type of particle into another. The Higgs boson is responsible for determining the masses of the particles.

Everything is made out of these fermions and bosons. Two up quarks and one down quark can combine to make a proton, and two down quarks and one up quark can combine to make a neutron. A cluster of protons and neutrons is called a nucleus. When electrons orbit around a nucleus, the resulting structure is called an atom. Atoms can combine to form molecules and molecules can combine to form even larger structures. In this way, all of the complexity and diversity of life can be explained by a single theory of fundamental particles.

The Standard Model is an elegant theory because it involves many mathematical symmetries, but it still doesn't explain gravity, dark matter, or dark energy.